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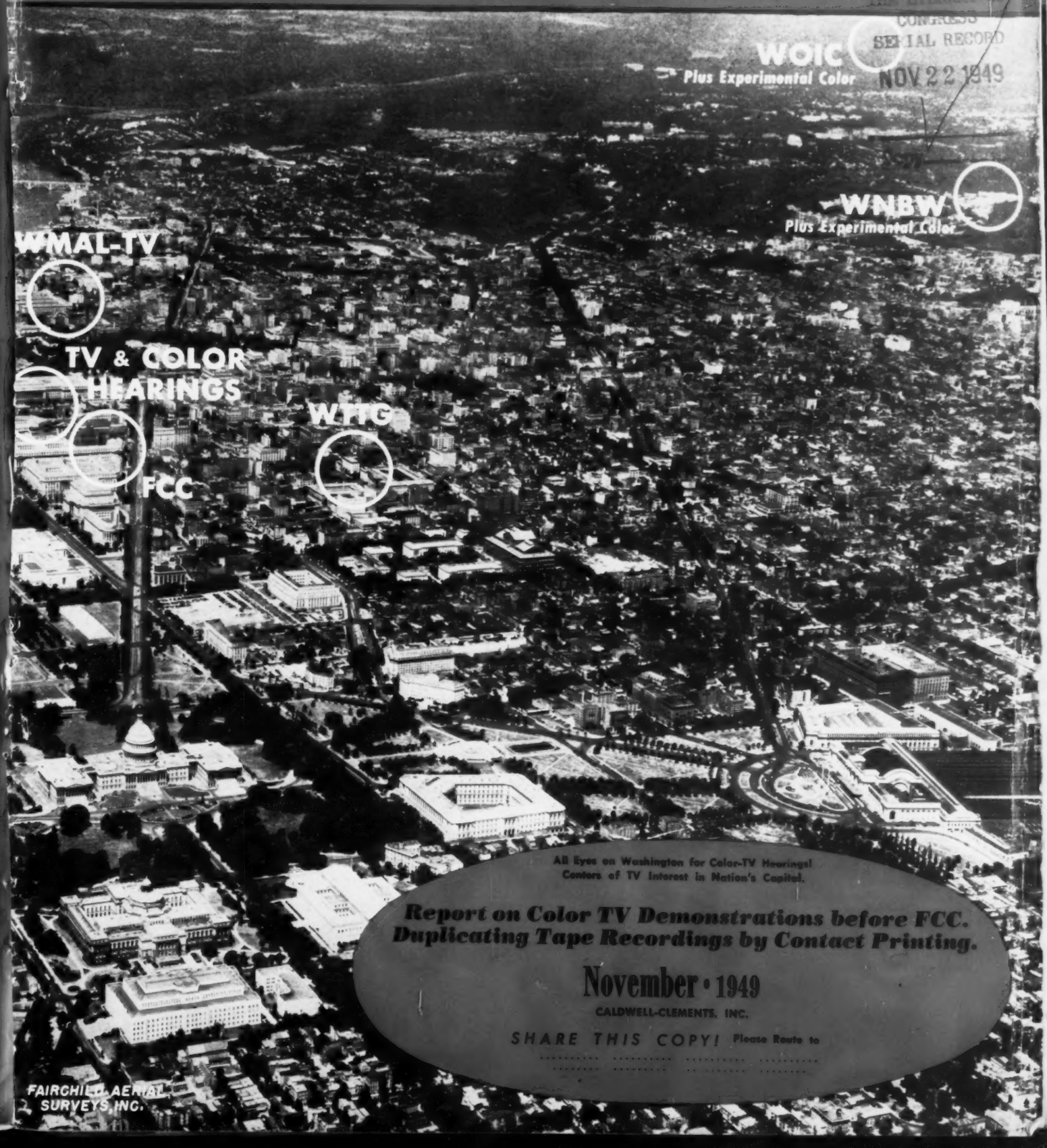

All Eyes on Washington for Color-TV Hearings! Centers of TV Interest in Nation's Capital.

Report on Color TV Demonstrations before FCC. Duplicating Tape Recordings by Contact Printing.

November • 1949

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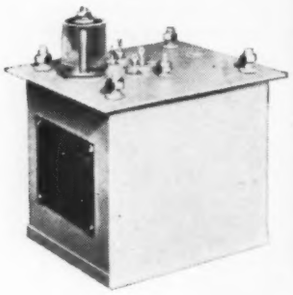
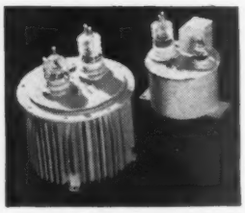


Pulse Transformers

Pulse transformers for use with either hard-tube or line-type modulators. Available in voltage ratings of 10 kv or above. These units are ideal for radar applications, stepping up or down, impedance matching, phase reversing and plate-current measurements. Also suitable for nuclear physics research work, television and numerous special applications in and out of the communications fields.



Resonant Reactors

Resonant-charging reactors, accurately designed and constructed for radar service. Usually required in ratings of 40 kv and below, 1 ampere and below and 300 henries and below. Higher ratings are being built, and can be considered. When required, small- and medium-size designs can be provided with 3 to 1 range of inductance adjustment.

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Edited for the 15,000 top influential engineers in the Tele-communications industry, Tele-Tech each month brings clearly written, compact, and authoritative articles and summaries of the latest technological developments to the busy executive. Aside from its engineering articles dealing with manufacture and operation of new communications equipment, Tele-Tech is widely recognized for comprehensive analyses and statistical surveys of trends in the industry. Its timely reports and interpretations of governmental activity with regard to regulation, purchasing, research, and development are sought by the leaders in the many engineering fields listed below

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NOVEMBER, 1949

COVER: An air view of Washington, presently in the nation's eye as the center of television activity. Manufacturers and broadcasters are anxiously awaiting developments there which will have a tremendous effect on their businesses. Circled are television stations and buildings where the FCC holds hearings.

REPORT ON FCC TV COLOR HEARING IN WASHINGTON 24
Color TV demonstrations are highlights of Washington hearings currently convened to determine fate of television

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DUPLICATION OF MAGNETIC TAPE RECORDING BY CONTACT PRINTING
Robert Herr 28
New method which needs no electrical transcription facilitates large scale production of pre-recorded programs

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Several new developments incorporate many 1947 PICAO recommendations. Extensive use of DME is expected by 1953

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MEASURING PHASE ANGLES IN COMMUNICATION CIRCUITS—PART 1
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A discussion of the problems for three-phase determining methods with suggested design criteria for new units

DR. LEE deFOREST'S COLOR-TV SYSTEM 41
New method employs oscillating tri-color filters in front of the picture pick-up and the reproducing tubes

PAGE FROM AN ENGINEER'S NOTEBOOK—NUMBER 4 43

VESTIGIAL SIDEBAND FILTER DESIGN—PART II
E. Bradburd, R. S. Alter, J. Racker 38
New unit for television transmitters employs purely reactive network in the attenuation of undesired signals

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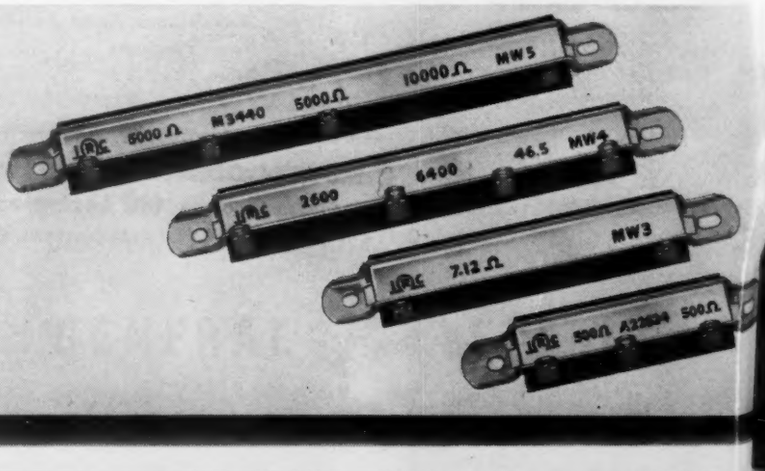

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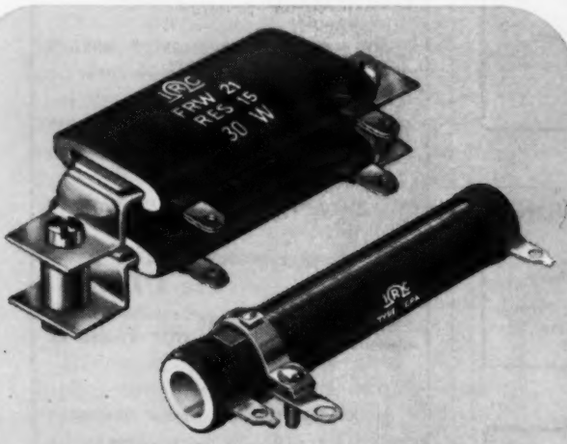

HIGHER SPACE-POWER RATIO than tubular power resistors makes IRC Type FRW Flat Wire Wounds ideal for voltage dropping applications in limited space. FRW's can be mounted vertically or horizontally, singly or in stacks—and are available in fixed or adjustable types. Bulletin C-1 gives all the performance facts.

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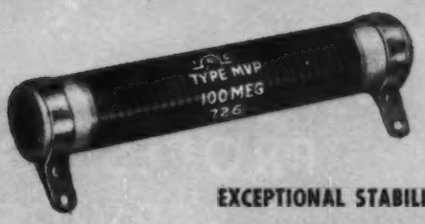

EXCEPTIONAL STABILITY even in very high resistance values assures the dependability of IRC Type MV Resistors in high voltage applications. Unique application of IRC's famous filament coating in helical turns on a ceramic tube provides a conducting path of long effective length, and permits the use of high voltage on the resistor while keeping the voltage per unit length of path comparatively low. Bulletin G-1 gives complete characteristics; use handy coupon.

LENGTH OF RESISTANCE PATH IN INCHES—FOR MV TYPES			
MVF	10	MVS	20
MVG	25	MVT	30
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MVP	80	MVD	95
MVA	190	MVZ	185
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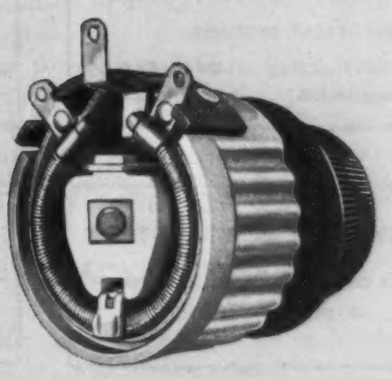

VARIABLE POWER requirements within 25 and 50 watt ratings are well handled by IRC Type PR Power Rheostats. All-metal corrugated construction gives maximum heat dissipation. PR Rheostats can be operated at full power in as little as 25% of rotation without appreciable temperature rise. Direct contact between housing and mounting panel increases ability to disperse heat. Bulletin E-2 details specifications; send for your copy.

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- ☐ MW Insulated Wire Wounds
- ☐ MV High Voltage Resistors
- ☐ PR Power Rheostats
- ☐ FRW Flat Wire Wounds
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Tele-Tech*, November 1949, Vol. 8, No. 11. 40 cents a copy. Published Monthly by Caldwell-Clements, Inc. Publication office, Orange, Conn. Editorial, Advertising and Executive Offices, 480 Lexington Ave., New York 17, N. Y. M. Clements, President; Orestes H. Caldwell, Treasurer. Subscription rates: United States and Possessions, $3.00 for one year, $5.00 for two years. Canada, $4.00 for one year, $6.00 for two years. All other countries, $5.00 for one year, $7.00 for two years. Please give title, position and company connection when subscribing. Entered as second class matter June 9, 1947 at the post office at Orange, Conn., under the act of March 3, 1879.

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New Higher Power Electron Tube with All-Ring Seals

Now Available for Full Power Operation Up to 110 mcs/sec.

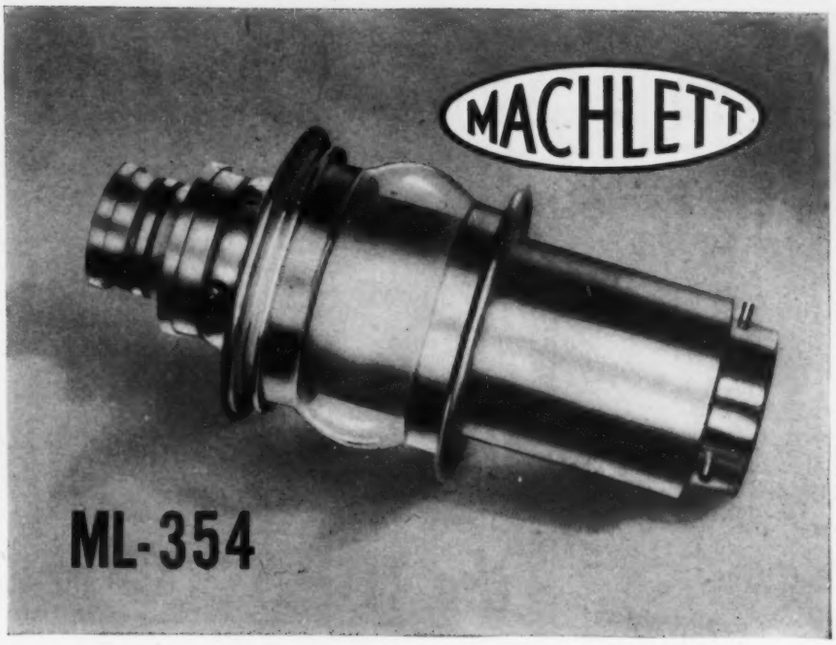
The availability of the Machlett ML-354, a compact, super-power water and forced-air cooled triode for operation up to 110 mcs/sec. in FM, AM, TV and industrial service is a contribution of significant proportion to progress in all fields of electronic development. The tube is provided with coaxial filament, grid, and plate seals, making it ideally suited to cavity-type circuits.

Superior Design Features

Developed to satisfy the need for higher-power electron tubes in broadcast, communications, research, and industrial services, this all-ring-seal triode is of a balanced electrical and mechanical design. Its low plate impedance makes it ideally suitable for broad band applications. All electrodes mount directly from heavy copper cylinders, resulting in a structure which is far superior, electrically and mechanically, to conventional water-cooled electron tube design; all glass-to-metal seals are of Kovar, and the large diameter seals give increased strength and freedom from excessive heating at electrode contacts. The tube incorporates a high-conductivity, heavy-wall copper anode. The integral anode water jacket and quick change water-coupling, contribute to easy and rapid tube replacement. The cathode is a 16 strand self-supporting thoriated-tungsten filament, completely balanced and stress-free throughout life. The rigidly supported grid and cathode are designed to give uniform anode heating. The grid is capable of unusually high heat dissipation contributing to maximum stability of tube performance and circuit operation.

Wide Application

The foregoing design features and characteristics are incorporated in the ML-354 triode, developed by Machlett Laboratories, Inc., Springdale, Conn. The ML-354, having basic design features usable over a wider range of power and frequencies than has been heretofore available in triodes, finds applications, among others, in high-power AM, FM and TV broadcasting, cyclotron and synchrotron oscillators and in induction and dielectric heating.



DESCRIPTION

The **ML-354** is a compact, general purpose, high power electron tube designed for operation at full power up to 110 mcs/sec. It is an all-ring-seal water and forced-air-cooled triode capable of giving in excess of 50 kilowatts output power at 108 mcs/sec. in grounded grid circuits with 10 kilowatts driving power. Considerably higher power is available at lower frequencies. This tube is ideally suited for cavity operation, and its low plate impedance is advantageous for broad band applications. Features include Kovar glass-to-metal seals, sturdy electrode structures, integral anode water jacket, and quick change water coupling. The cathode is a stress-free self-supporting thoriated-tungsten filament.

GENERAL CHARACTERISTICS

Electrical		Mechanical	
Filament Voltage	12.5 volts	Mounting	Vertical, Anode Down
Filament Current	220 amps	Water-flow on Anode	
Amplification Factor	25	for 75 KW Dissipation	45 gpm
Interelectrode Capacitances		for 50 KW Dissipation	30 gpm
Grid-Plate	65 uuf	Air Flow on Seals	
Grid-Filament	83 uuf	to limit glass to 165°C.	220 cfm
Plate-Filament	2.4 uuf	Net Weight, approximate	40 lbs

MAXIMUM RATINGS: Radio-Frequency CW Oscillator

	Max. Freq. 50 mcs/sec.	*Max. Freq. 110 mcs/sec.*	
DC Plate Voltage	15	9	kVdc
DC Plate Current	13	13	Adc
DC Grid Voltage	−1.6	−1.6	kVdc
DC Grid Current	2.5	2.5	Adc
Plate Input	195	100	kW
Plate Dissipation	75	50	kW

For complete technical data on the ML-354 high power, all-ring-seal triode, write to Engineering Department,

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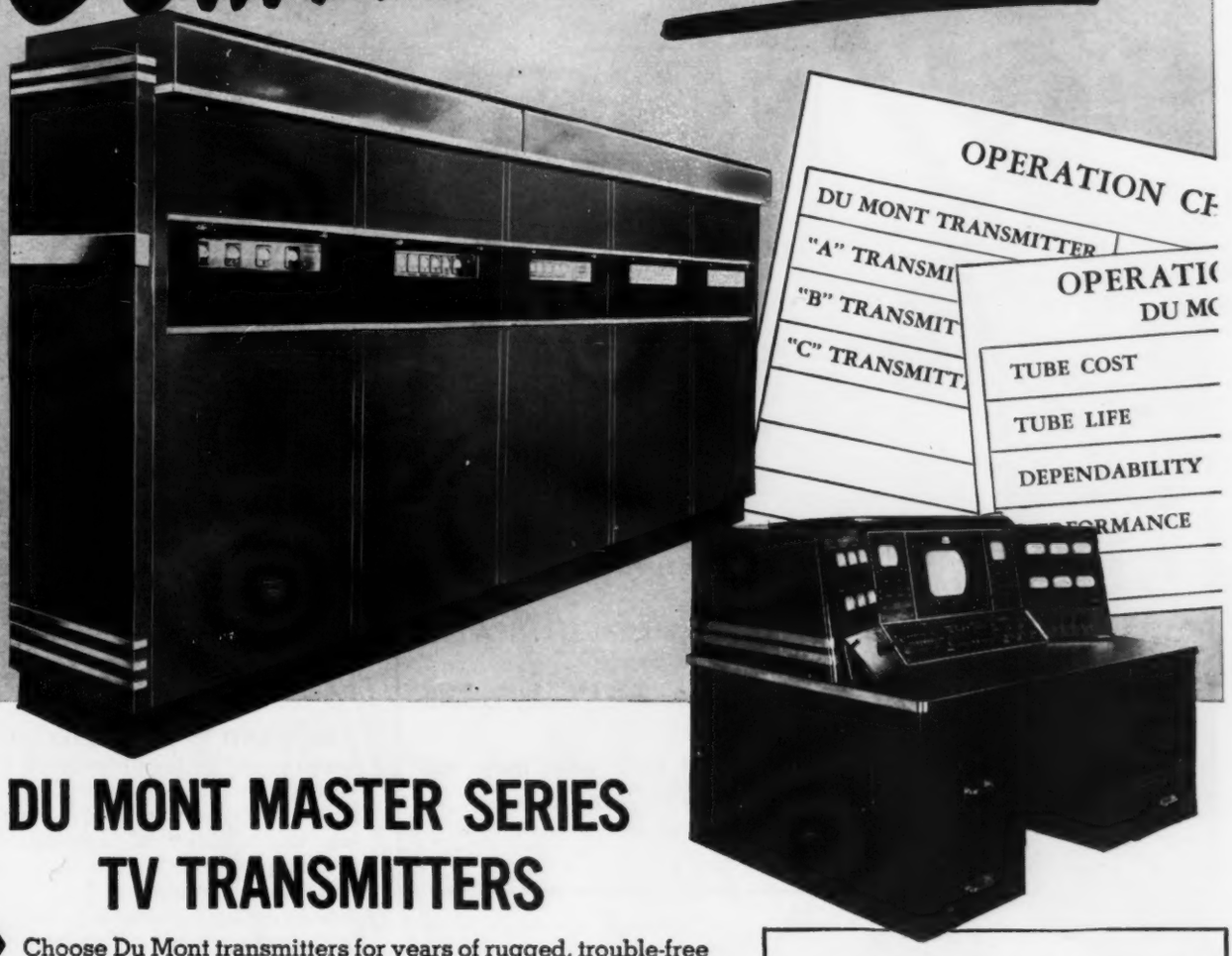

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TELE-TIPS

HIGH-POWER FM—During the September 27-30 period, the FCC granted 30 FM stations licenses to operate at full power. Three were granted licenses to operate at 50 KW or more, two at 40 KW or more and five at 20 KW or more.

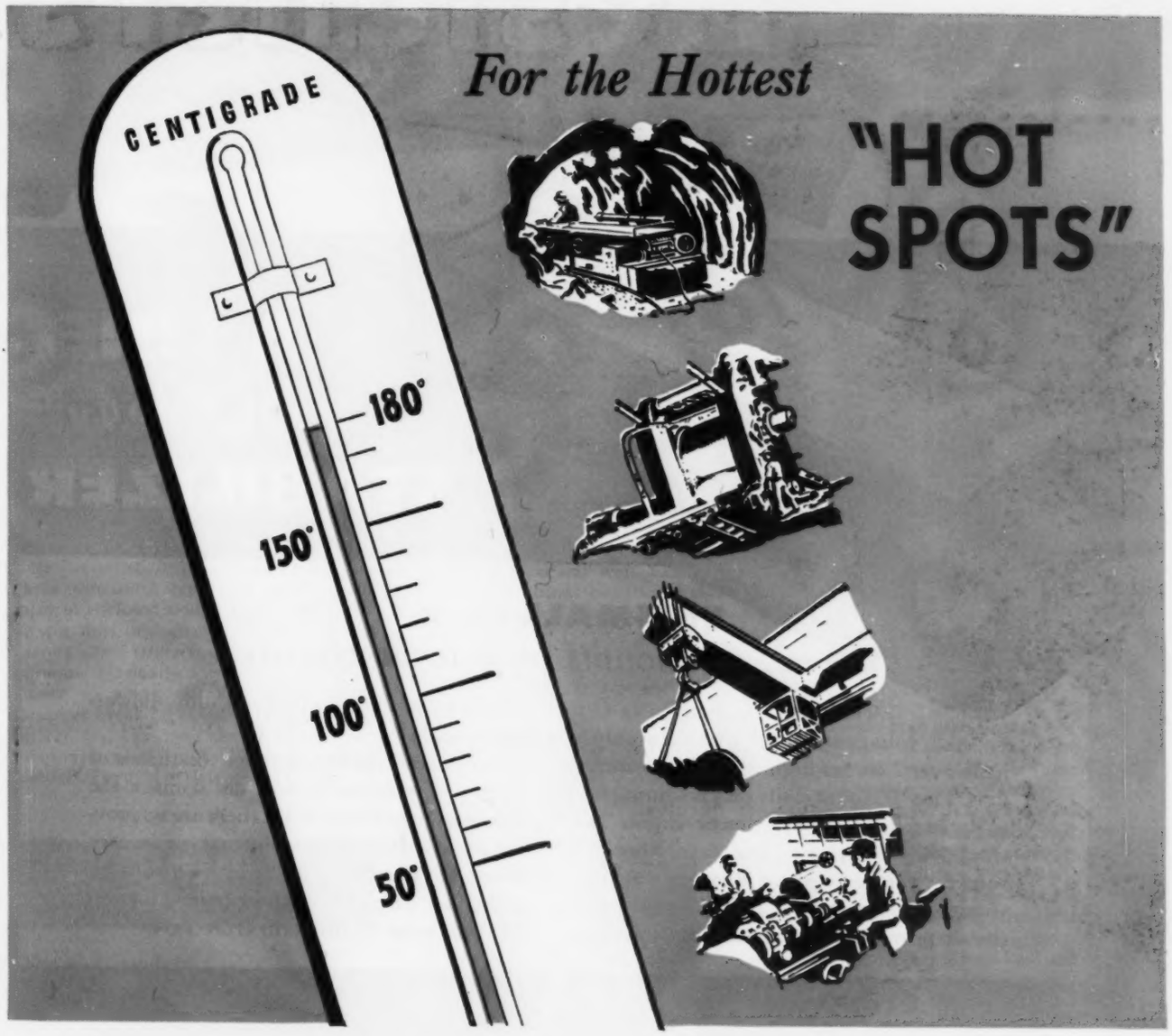
INDUCTANCE EXTREMES—As a variation from the infinitesimal inductances used in microwave work, the United Transformer Company of New York City has produced for the Austin Company, station erectors, what is probably the world's largest inductance, electrically speaking. This inductance of 300,000 henries, 15,000 ohms resistance and current capacity of 50 μA, is contained in a 10-in. cube and weighs 80 lbs. Some very concentrated design work must have been involved in this "coil".

220-MILE TV—KGO-TV signal from San Francisco is being received regularly and clearly at a tavern in Reno, Nevada, about 220 miles away

MILLENIUM AT HAND?—Latest development in the program of eliminating man's labor is the Illinois Institute of Technology report announcing the commercial application of synthetic sound. This is to "sound" what the animated cartoon was to moving-picture production. However, in this case, sounds which have never been produced are heard! The principle has long been known, but it required the concentrated efforts of Robert E. Lewis, a physicist at the Armour Research Foundation, and Norman McLaren of the National Film Board of Canada to develop the technique used in the first sound movie ever to be made which did not use any sound recording devices.

MUSICAL TYPEWRITER—In the past sound patterns have been drawn with brush or pen and ink on film which when run in a sound projector produced intelligible sounds. However, now that the above team has worked out the mathematics of drawing rhythm, pitch and amplitude on a sound track the way has been opened for the eventual production of a musical typewriter which when struck will produce the characteristic pattern for any sound or combinations of sounds. Thus a symphony could be written, orchestrated and recorded, without a note having been played!

A MAGNET WIRE



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Even at operating temperatures around 180° C, here's what Silotex offers: Greater life expectancy, greater over-load protection, immunity to ambient temperature, greater moisture resistance, reduction in fire hazard. For complete information on the properties of Silotex, write to Anaconda Wire and Cable Company, 20 N. Wacker Drive, Chicago 6, Ill.

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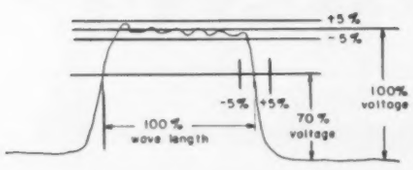
. . . it mounts on a radio chassis

These 15-, 25-, and 50-va G-E voltage-stabilizer units are only a little over 2 inches high and about 9 inches long. They'll mount easily on a medium-sized radio or electronic instrument chassis and will give you an even, non-fluctuating 115 volts for your equipment whether your line voltage is 95 or 130. A special transformer circuit provides a stabilized output voltage within 1% of 115 volts for fixed, unity-power-factor loads.

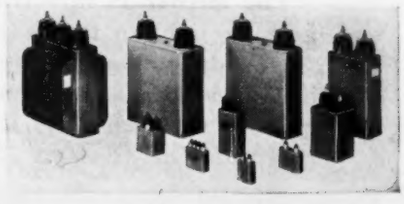
Continuous operation under conditions of short or open circuits will not damage the stabilizer in any way. Since there are no moving parts, there is little maintenance to worry about. For complete information on voltage-stabilizer units of all sizes from 15-va to 5000-va, write for Bulletin GEA-3634.

AN EASY WAY TO PRODUCE SQUARE WAVES



Specially designed G-E Type-E networks will produce impulses which have definite, known energy contents and durations, and thus are ideal for converting a-c or d-c charging voltages into approximately rectangular square waves. These networks consist of capacitor and coil sections adjusted to close tolerances and hermetically sealed in single metal containers.

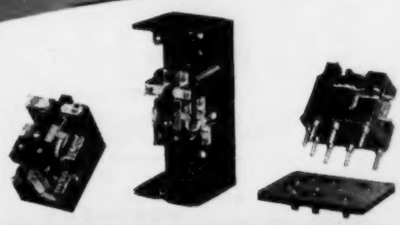
G.E. helped meet wartime radar demands with thousands of these units and now offers them for commercial use. They are available in a wide range of designs, impedances, ratings, and sizes for pulse lengths of 0.1 to 40 microseconds. See Bulletin GEA-4996.



GENERAL ELECTRIC

Digest

TIMELY HIGHLIGHTS ON G-E COMPONENTS



HEAVY-DUTY RELAYS THAT MOUNT 3 WAYS

This versatile, general-purpose, heavy-duty, a-c relay unit is available in three mounting arrangements: front connected, back connected, or plug-in connected. All three mounting types are available in open or enclosed models and are furnished in spst, dpst, or dpdt circuits. Heavy, long-lasting silver contacts carry 10 amps continuous. Normally-open forms make or break 45 amps; normally-closed forms make or break 20 amps. Relay coils come in 12-, 24-, 115-, or 230-volt, 60-cycle a-c sizes. D-c units are available in similar models. For full details see GEC-257.

ACCURATE BUT RUGGED

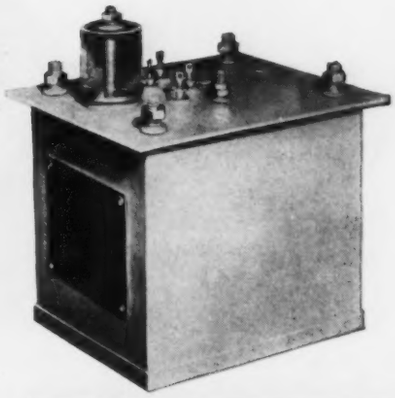
The new, modern-looking, easy-to-read 2½ inch G-E instrument line is improved inside as well as outside. A single, self-contained mechanism supported on an extremely strong Alnico magnet assures permanent alignment even under the most adverse operating conditions. This high-gauss Alnico magnet permits the use of a large air gap with a consequent smoother, non-sticking action. The greater torque-to-weight ratio means better damping and allows the use of heavier vibration-resisting pivots. Accuracy is 5% of full scale on rectifier types, 2% on all others. For complete details, send for Bulletin GEC-368.

SNAP-SWITCH INSTALLATION TIME CUT TO SECONDS

You'll have a firm electrical connection without the use of solder a few seconds after you begin to install this small but rugged Switchette. Only 1½ inches long and weighing only 9 grams, this 230-vac, 10-amp unit has solderless knife-contact terminals made of pure, tinned copper.

G-E Switchettes are available in a variety of forms and circuits, all of which have double-break contact structures. They're particularly well suited for electronic applications because of their low RF noise output (short contact-bounce).

For your convenience there are screw-terminal and soldering-lug types as well as this special quick-connect unit. Send for Bulletin GEA-4888.



A SMALL PACKAGE OF WELL-REGULATED HIGH VOLTAGE

You get both high voltage and good regulation with small lightweight G-E precision rectifiers. This may interest you if you need compact, well-regulated, high d-c voltage sources for cathode-ray tubes, television camera tubes, radar indicator scopes, electron microscopes, Geiger-Mueller counters, or similar jobs.

These supplies are hermetically sealed and oil-filled. Typical units have outputs of 7 kv at 0.1 ma.—have only 3.5% deviation for every 0.1 ma load and output ripple of less than 1%. Size—only 6" x 6" x 7". Weight—8 lbs. For further data, write: General Electric Company, Section 667-3, Schenectady 5, N. Y., giving complete information on the proposed application with specifications required.

General Electric Company, Section E667-3
Apparatus Department, Schenectady, N. Y.

Please send me the following bulletins:

- ☐ GEA-3634 Voltage stabilizers
- ☐ GEA-4888 Switchettes
- ☐ GEA-4996 Capacitor networks
- ☐ GEC-257 Heavy-duty relays
- ☐ GEC-368 Instruments

NAME_____

COMPANY_____

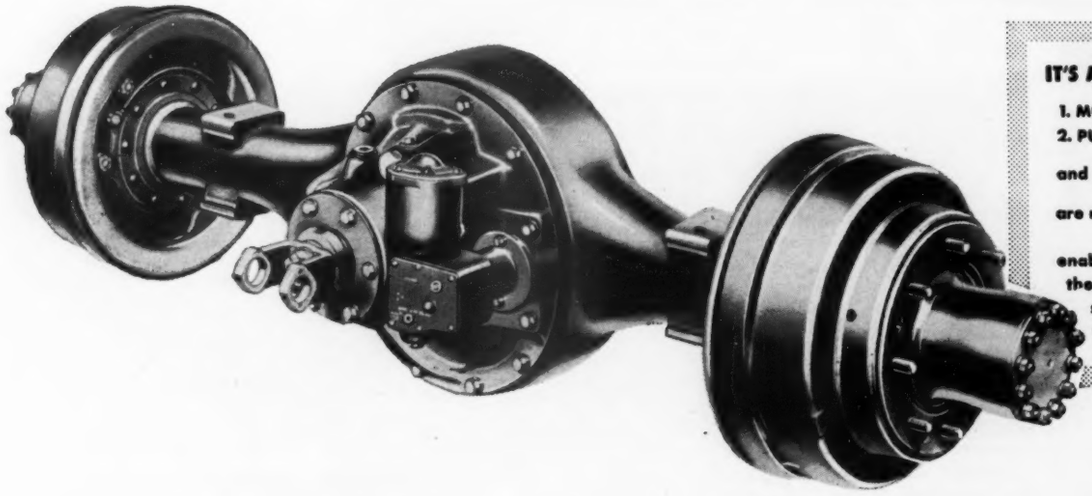
ADDRESS_____

CITY_____ STATE_____

MALLORY

Takes Nothing For Granted...

and the Eaton Manufacturing Company is Pleased!



IT'S A SNAP TO SHIFT

1. MOVE BUTTON
2. PUSH PEDAL

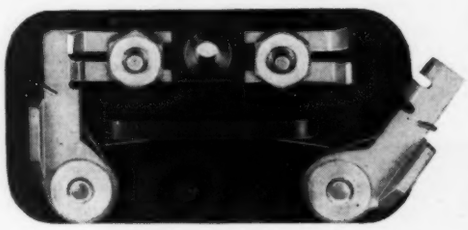
and your speed ratios ●●●● are now doubled ●●●●●●●● enabling you to match the load to the road saving engine, time and fuel.

The popular Eaton 2-speed truck axle is controlled by a little button. The driver moves it and the truck's speed ratios are doubled in number. Crushing loads start with ease. Rough uphill hauls in quarries or in construction jobs are a cinch. And owners save wear, tear and money on their truck equipment!

When planning the electric shift, the Eaton Company submitted specifications for the required switch to Mallory.

Mallory engineers looked at the design submitted to them with inquisitive eyes. Backed by the greatest pool of experience and skill in the field, Mallory engineers suggested manufacturing methods that resulted in appreciable production cost savings at no sacrifice in performance.

If you are in the throes of a design problem calling for precision electronic parts—switches, controls or resistors—it will pay you to call in Mallory engineers now. Their record in the industry is famous. Because they take nothing for granted, you'll be sure of getting the finest design at the best possible price.



Clean-cut, simple, long wearing and trouble-free, this Mallory-made switch used to activate the Eaton 2-speed axle is typical of the kind of product that has made Mallory "switch headquarters" for American industry.

Precision Electronic Parts—Switches, Controls, Resistors

P. R. MALLORY & CO. Inc.

MALLORY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

SERVING INDUSTRY WITH

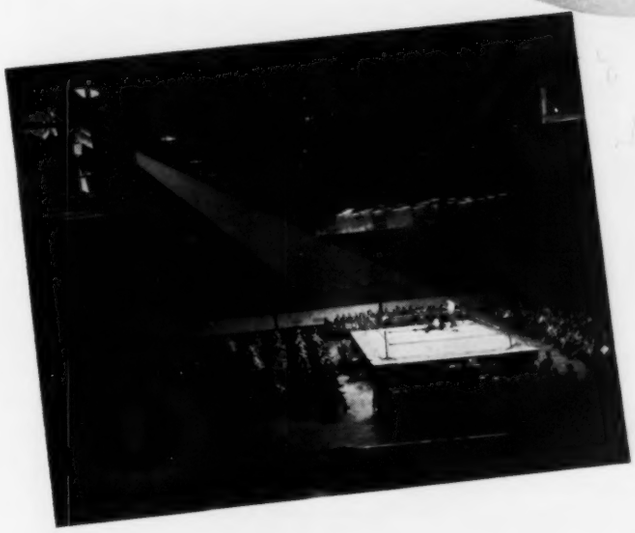
Capacitors — Rectifiers
Contacts — Switches
Controls — Vibrators
Power Supplies
Resistance Welding Materials

A NEW SPOTLAMP FOR TV STUDIOS

The STRONG TROUPER

Portable High Intensity A. C. CARBON ARC SPOTLIGHT

Permits better showmanship — and better lighting.



Produces snow white uniformly illuminated spot, with crisp edges, far surpassing in brilliancy any incandescent or vertical arc type spotlights. Delivers light of a quality ideal for TV.

Easily operated. Start it and forget it. You'll appreciate the unattended operation.

A silvered glass reflector and two-element variable focal length lens system.

Draws only 10 amperes from any 110-volt A.C. convenience outlet. Adjustable, self-regulating transformer which is an integral part of the base for the first time makes possible a high intensity arc spotlight without the use of heavy rotating equipment.

Automatic arc control maintains constant arc gap and a steady light, free from hiss or flicker. The airborne hum level does not interfere with sound. A trim of carbons burns one hour and twenty minutes at 21 volts and 45 amperes.

Horizontal masking control. Can be angled at 45 degrees in each direction.

Mounted on casters. Easily transported to remotes.

THE STRONG ELECTRIC CORPORATION

"The World's Largest Manufacturer of Projection Arc Lamps"

3 City Park Avenue. Toledo 2, Ohio

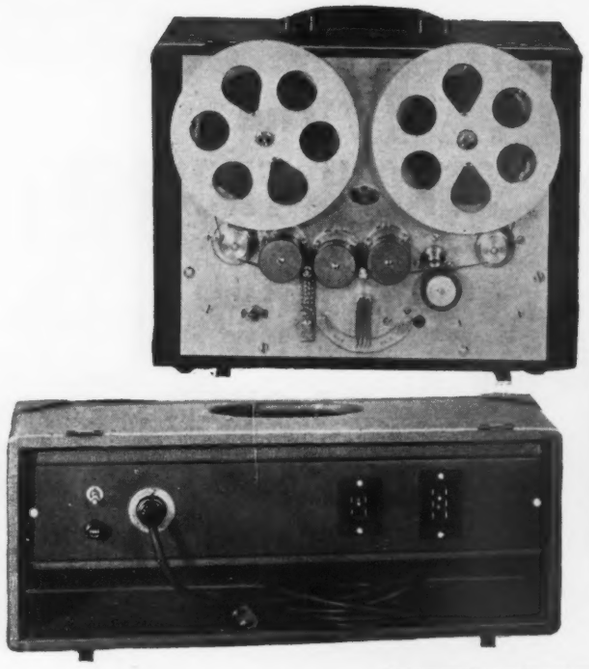
Please send free literature, prices and name of the nearest dealer in Strong Spotlights

NAME .....

COMPANY .....

STREET .....

CITY & STATE .....

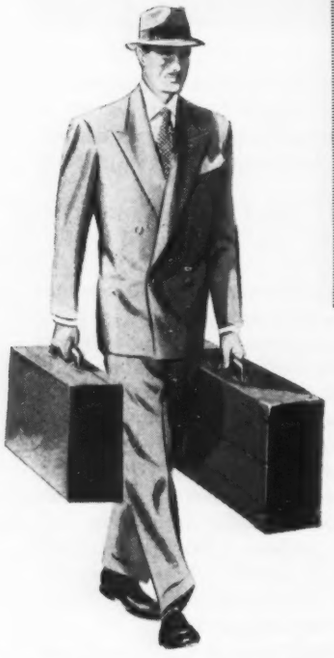


comparisons

indicate this is the world's finest recorder of its type

NEW PRESTO

Portable Tape Recorder PT-900



Complete in two easily portable cases—one containing the recorder, the other the amplifying equipment.

MANY OUTSTANDING FEATURES:

- Three separate heads for superior performance (and for monitoring direct from tape). One head each to erase, record and play back.
- 3 microphone channels with master gain control in recording amplifier.
- Large V.U. meter with illuminated dial to indicate recording level, playback output level, bias current and erase current, and level for telephone line.
- 2-speed, single motor drive system. Toggle switch to change tape speeds from 7½" to 15" per second.

Don't choose your tape recorder until you see the *new* Presto Portable Tape Recorder. Write for complete details today.

Write today to be put on our mailing list for "The Presto Recorder," new house organ of practical ideas for anyone in the recording and broadcasting field.

PRESTO
RECORDING CORPORATION
Paramus, New Jersey

Mailing Address: **P. O. Box 500, Hackensack, N. J.**
In Canada: WALTER P. DOWNS, Ltd., Dominion Square Building, Montreal

WORLD'S LARGEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT AND DISCS

1N34A and 1N58A

SYLVANIA GERMANIUM DIODES

now...

Sealed in Glass!

Smaller, lighter, moisture-proof. Can be mounted side by side without danger of shorting.

Sylvania Electric now offers smaller, lighter germanium diodes hermetically sealed in glass. This construction makes diodes moisture-proof —gives greater electrical stability. And they cost no more than corresponding ceramic types.

These new smaller size glass diodes are ideal for side-by-side mounting—no risk of accidental contact.

Glass types are identified by the suffix "A." Types 1N34A and 1N58A are currently available; other types will be announced from time to time.

Sylvania Electric Products Inc.
Electronics Division, Dept. E-3111
500 Fifth Avenue, New York 18, N. Y.

Please send me information on your new Sealed-in-Glass Germanium Diodes—and also your complete catalog of Sylvania electronic products.

Name_____

Position_____

Company_____

Street Address_____

City_____ State_____

SYLVANIA ELECTRIC

ELECTRONICS DIVISION, 500 FIFTH AVENUE, NEW YORK 18, N. Y.

ELECTRONIC DEVICES: RADIO TUBES: CATHODE RAY TUBES: PHOTOLAMPS: FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES, SIGN TUBING: LIGHT BULBS

STAY AHEAD IN CHOOSE

CHARACTERISTICS
TYPE 16GP4

Max bulb diameter	16 inches
Min useful screen diameter	14⅜ inches
Heater voltage	6.3 v
Heater current	0.6 amp
Focusing method	magnetic
Deflecting method	magnetic
Deflecting angle (approx)	70 degrees
Screen fluorescent color	white
Over-all length	17 1⅛ inches (max)
Bulb contact	metal-cone lip
Base	small-shell duodecal 5-pin

Max ratings, design-center values

Anode voltage	14,000 v
Grid No. 2, voltage	410 v
Grid No. 1, voltage	—125 v

Typical operating conditions

Anode voltage	12,000 v
Grid No. 2, voltage	300 v
Grid No. 1, voltage for cut-off	—55 v

TYPE 16GP4

16-inch metal picture tube, with wide-angle (70-degree) sweep, and high-contrast-glass face. Designed for modern receivers where size of the cabinet is restricted, yet the picture must be large, clear, and sharp. . . . Tube is less than 18 inches long; its weight is approximately half that of an all-glass type. . . . Generous picture area is 163 sq. inches when the entire tube face is scanned; 132.5 sq. inches when standard raster of 3-by-4 aspect is employed. . . . Special high-contrast-glass face helps produce a clear image with superior definition.

TELEVISION! GENERAL ELECTRIC TUBES!

LEAD, or be left behind! Designers and builders of TV receivers face that challenge. By specifying General Electric tubes, you (1) help assure the over-all advanced design of your product, and (2) make a popular move to meet the demand of buyers for what's newest and best in television home equipment.

Progress shows, for example, in every characteristic of G.E.'s new 16-inch wide-angle picture tube. Because of its comparatively short length, you can design a receiver about Type 16GP4 that will fit conveniently into the average small living-room. At the same time, the picture area is large, giving excellent visibility for a good-sized group of guests. The face of the tube is a special new dark-tone glass providing high contrast . . . images show more clearly, with sharper definition.

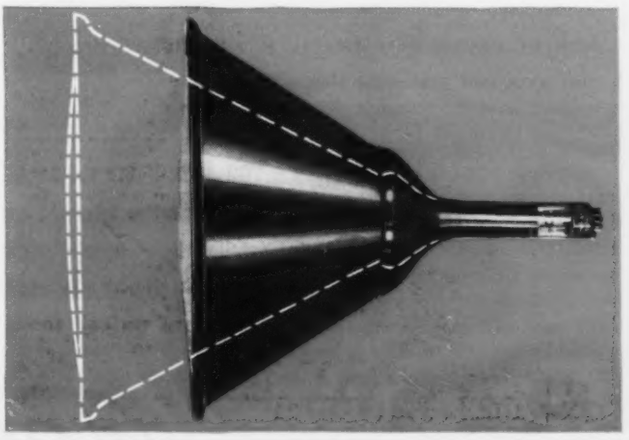
G-E receiving tubes of advanced design spell progress and economy. The new 6BN6, a miniature gated-beam tube, functions as a limiter, discriminator, and audio-amplifier in TV and FM receivers, thereby replacing 3 tubes and associated components.

Other G-E picture tubes—Types 8AP4, 10BP4, 10FP4, 12KP4 and 12LP4—share in the advancements being recorded by General Electric's continuous research in television. And a full line of G-E receiving-type tubes is available, including such outstanding new designs for television use as the 6AB4, 6BN6, 12AT7, 12AU7, and 12AY7.

Choose General Electric tubes to make sure the product you design, build, and sell is in the forefront competitively! Experienced G-E tube engineers will be glad to work with you in selecting the right types for your circuit. Wire or write today to *General Electric Company, Electronics Department, Schenectady 5, New York.*

SHORTER—MAKES POSSIBLE A MORE COMPACT TV RECEIVER

Why Type 16GP4 picture tube is nearly 5 inches shorter than the standard 16AP4 16-inch type, is shown here. A sweep angle of 70 degrees for the 16GP4 against 53 degrees for the 16AP4 (portrayed in dotted lines) results in a flatter conical shell. This reduces the over-all length of the tube to 17 11/16 inches, compared with 22 5/8 inches for the 16AP4. Receivers using the new tube can be shorter and less bulky, consequently are more acceptable in the home.



You can put your confidence in—

GENERAL ELECTRIC

181-H2

ENGINEERED AND PRODUCED TO MEET

Your Special Problems

COSMALITE* ENSURES SATISFACTION

Spirally Laminated Paper Base Phenolic Tubing

#46 COSMALITE is designed for application where punching and stapling qualities are important. It is especially adaptable for threading or other requirements.

#SLF COSMALITE is designed for thin wall applications such as permeability tuners. It has unusual strength and excellent electrical properties.

#96 COSMALITE is the standard for all radio and television applications. It possesses excellent electrical and mechanical qualities and meets coil form requirements with high electrical strength and minimum surface leakage.

#102 REGULAR COSMALITE, designed for low moisture absorption, low power factor, low surface leakage and high dielectric strength. Especially suitable for use with frequencies as high as the ultra high frequency band.

#102 MODIFIED COSMALITE retains the excellent electrical properties of #102 along with the mechanical and versatile advantages of #96 COSMALITE. Designed especially for high voltage applications where staples or rivets are fastened on coil forms.

* Reg. U.S. Pat. Off.

COSMALITE, backed by over 25 years of experience, equals or exceeds the performance of any phenolic tubing available.

Consult us on your needs.

The CLEVELAND CONTAINER Co.

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PLANTS AND SALES OFFICES at Plymouth, Wisc., Chicago, Detroit, Ogdensburg, N.Y., Jcmesburg, N.J.
ABRASIVE DIVISION at Cleveland, Ohio
CANADIAN PLANT: The Cleveland Container, Canada, Ltd., Prescott, Ontario

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A New Standard of Performance for Cathode-ray Oscillographs

DU MONT TYPE 304-H

NEVER BEFORE HAVE THESE FEATURES BEEN COMBINED IN *ONE* INSTRUMENT AND OFFERED AT SUCH *LOW COST!*

HIGH-GAIN AMPLIFIERS X- AND Y-AXES

Sensitivity: X-Axis, 50 millivolts rms per inch (AC and DC). Y-Axis, 10 millivolts rms per inch (AC and DC).

Frequency Response: DC amp. X and Y Axes, 0-100,000 cps within 10%; 0-300,000 cps within 50%. AC amp. X and Y Axes, 20-100,000 cps within 10%; 20-300,000 cps within 50%.

No pattern "bop" even with sudden changes in signal level. Excellent stability and minimum microphonics and drift. Provision for applying signals directly to deflection plates.

STABILIZED SYNCHRONIZATION

Sync limiting provided on recurrent sweep, so that sweep length and synchronization are maintained as signal level varies.

EXPANSION OF DETAILS

Due to available deflection of over 4 times full-screen diameter on both X and Y Axes, performance equivalent to that of a 20-inch cathode-ray tube is possible, with the high resolution of a 5-inch screen. Full positioning is available over this entire expanded range on both axes.

RECURRENT AND DRIVEN SWEEPS

Variable from 2 to 30,000 cps. Sweep speeds faster than 0.75 inch/μsec. with fully expanded time base. Provision incorporated for sweeps of 10 seconds and slower through the connection of external capacitors at front-panel terminals. Sync amplifier with sync-polarity selection is provided.

INTENSITY MODULATION

Z-Axis input terminal on front panel is capacitively coupled to grid of cathode-ray tube. 15 volts peak will blank trace fully at normal intensity.

INCREASED ACCELERATING POTENTIAL

Du Mont Type 5CP-A Cathode-Ray Tube in the Type 304-H is operated at overall accelerating potential of 3000 volts, facilitating use of long-persistence screens to take full advantage of low-frequency recurrent sweeps, fast-driven sweeps, and DC amplifiers. Type 304, a lower-price version, is also available, operating at an overall accelerating potential of 1780 volts.

ADDITIONAL FEATURES

An engraved, permanently-mounted calibrated scale greatly facilitates quantitative measurements. Mu-Metal magnetic shield affords maximum protection of cathode-ray tube from effects of external magnetic fields. Du Mont Type 2501 Bezel permits attachment of such accessories as Du Mont Types 271-A or 314-A Oscillograph-Record Cameras.

MECHANICAL DETAILS

Height, 13½"; Width, 8⅝"; Depth, 19"; Weight, 50 lbs. Housed in metal cabinet with gray wrinkle finish. Panel reverse etched—white on gray.

TRIED AND PROVED

This oscillograph has undergone a most rigid field test both in our own laboratories and again in selected laboratories and institutions throughout the country. In a great variety of applications, every feature has been given a thorough workout. The Type 304-H is not a new instrument of unknown quality, but definitely an oscillograph of TRIED AND PROVED EXCELLENCE.

PRICES

Type 304-H, $307.50. Type 304, $285.00.

Full details of performance and applications are contained in a 12-page bulletin obtainable by writing to . . .

© ALLEN B. DU MONT LABORATORIES, INC.

ALLEN B. DU MONT LABORATORIES, INC.
CLIFTON, NEW JERSEY

Smaller

METALLIZED-PAPER CAPACITORS

Here's a 150 volt 5 mfd. Aerolite* metal-cased unit contrasted with the usual paper-and-foil capacitor of equivalent rating. Its Aerolite* hermetically-sealed metallized-paper section means smaller size, lighter weight, performance reliability, *plus* the unique *self-healing* characteristic. Aerovox application engineering assures satisfactory usage.

Smaller

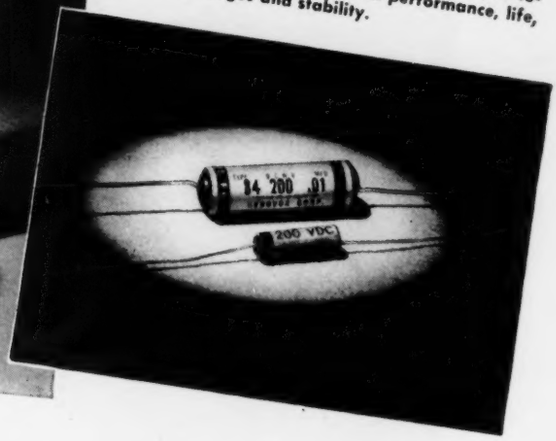
BANTAM* ELECTROLYTICS

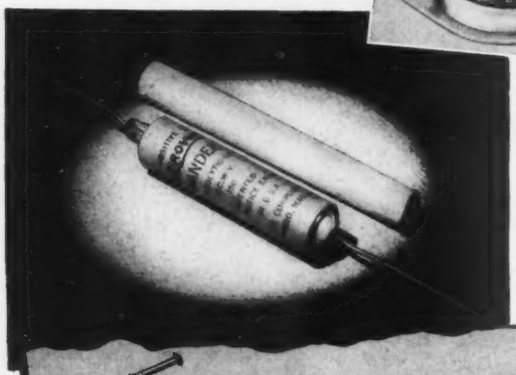
Type SRE Bantams* are the smallest electrolytics yet! Especially suitable for cathode by-pass applications, screen filter circuits and similar functions. Improved processing and materials combined with more efficient space utilization, means smaller size and no reduction in life.

Smaller

METALLIZED-PAPER TUBULARS

Aerolite* Type P'82 (front) and Type '84 usual tubulars are further examples of Aerovox's long line of size reductions. These miniature paper tubulars provide the maximum in performance, life, operating ranges and stability.





SMALL . . . SMALLER . . . Smallest

AEROVOX *Capacitors*

WE MUST KNOW . . .

1 Life . . . . . ?
2 Operating Voltage . . . . . ?
3 Maximum Surge Voltage . . . . . ?
4 Maximum Ambient Temperature ?
5 Duty Cycle . . . . . ?
6 Humidity . . . . . ?
7 Altitude . . . . . ?
8 Shock . . . . . ?
9 Terminals . . . . . ?
10 Mounting . . . . . ?

● How small is *small*? The radio-electronic miniaturization trend poses the question. And here's the Aerovox answer:

Small in capacitors means the *minimum size* required to meet *actual performance requirements*. There must be no secrets as to the operating conditions. To give you a true miniature capacitor, we must know the facts called for by the accompanying questions.

How small is *small*? Let Aerovox engineers, with their latest techniques and production processes, give you the *practical* answer.

● ***Submit your miniaturization or other capacitance requirements for engineering collaboration and quotations.***

*Trade-marks

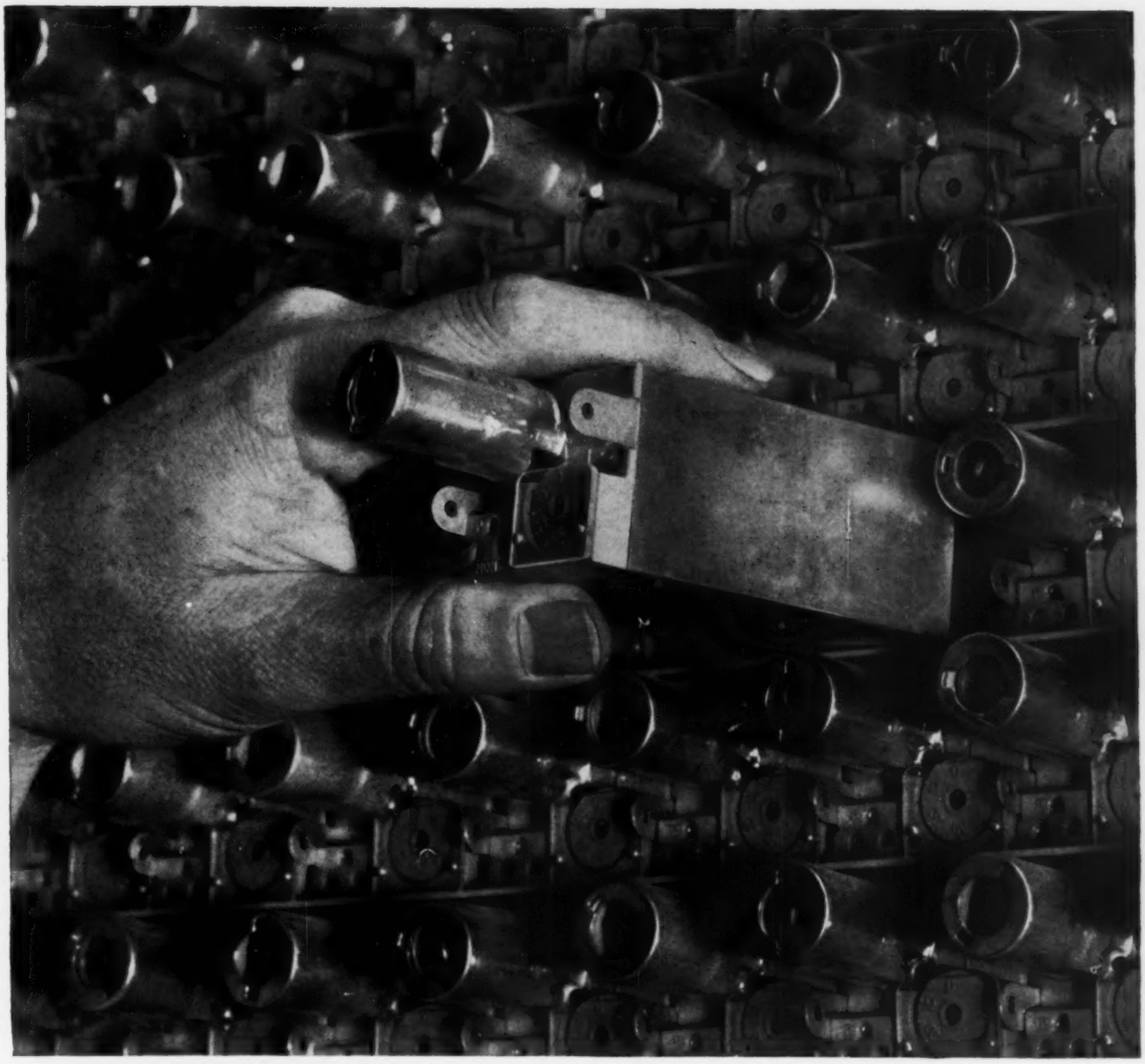
AEROVOX capacitors

FOR RADIO-ELECTRONIC AND INDUSTRIAL APPLICATIONS

AEROVOX CORPORATION, NEW BEDFORD, MASS., U.S.A.

SALES OFFICES IN ALL PRINCIPAL CITIES • Export: 13 E. 40th St., New York 16, N. Y.

Cable: 'ARLAB' • In Canada: AEROVOX CANADA LTD., HAMILTON, ONT.



ANOTHER SCORE IN THE

battle of the inches

It takes many costly buildings to house your telephone system. Every inch saved helps keep down the cost of telephone service. So at Bell Telephone Laboratories engineers work constantly to squeeze the *size* out of telephone equipment.

In the picture a new voice frequency amplifier is being slipped into position. Featuring a Western Electric miniature vacuum tube, tiny permalloy transformers, and special assembly techniques, it is scarcely larger than a single vacuum tube used to be. Yet it is able to boost a voice by 35 decibels. Mounted in a bay only two feet wide and 11½ feet high, 600 of the new amplifiers do work which once required a *room* full of equipment.

This kind of size reduction throughout the System means that more parts can be housed in a given space. Telephone buildings and other installations keep on giving more service for their size — and keep down costs.

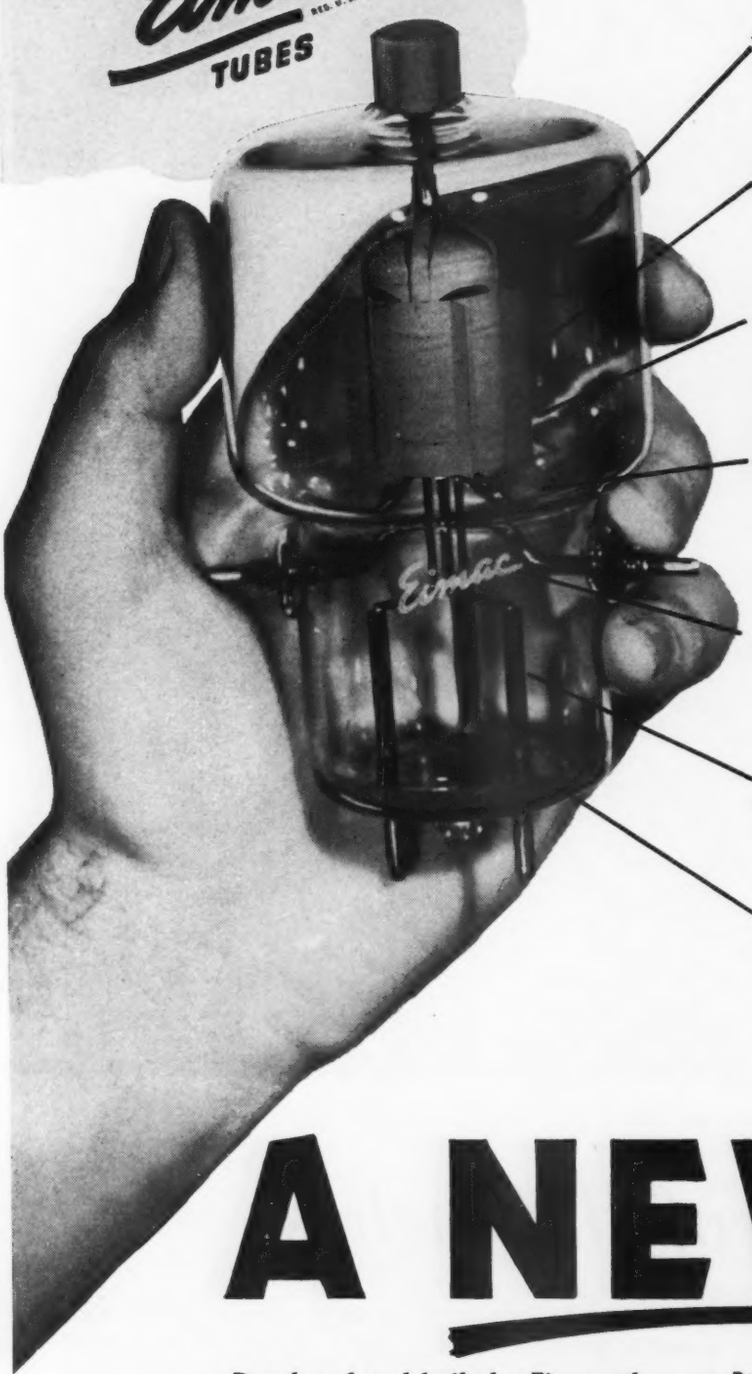
The new amplifiers, which will soon be used by the thousands throughout the Bell System to keep telephone voices up to strength, are but one example of this important phase of Laboratories' work.

BELL TELEPHONE LABORATORIES EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE

Follow the Leaders to

Eimac REG. U. S. PAT. OFF.

TUBES



★ **Pyrovac plate . . . for long life and to withstand momentary overloads.**

★ **Eimac non-emitting grid . . . for stability of operation.**

★ **Component materials are chemically stable . . . insuring long filament life.**

★ **Mechanical design of internal structures produces a high degree of rigidity and resistance to physical abuse.**

★ **Trade-marked "Eimac" . . . your assurance of superior performance and continuing service.**

★ **Tungsten leads . . . for low R-F resistance.**

★ **Eimac moulded glass base and precision aligned base pins.**

A NEW 592

Developed and built by Eimac, the new 3-200A3/592 is directly interchangeable with existing tubes marked 592 without equipment modification.

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TELE-TECH

TELEVISION • TELECOMMUNICATIONS • RADIO

O. H. CALDWELL, Editorial Director ★ M. CLEMENTS, Publisher ★ 480 Lexington Ave., New York (17) N. Y.

MUNITIONS SPEED-UP—Discovery that the Russians have the atomic bomb is going to mean a rapid increase in US military expenditures for defense. Additional billions will have to be poured into our Army, Navy and Air Force programs. And based on past experience, this means that at least 20% of the huge new outlays will go for radio, radar and electronic apparatus. (In the case of the great new bombers even 40% of the cost is radio-electronic.) These new demands will be felt with repercussions throughout the whole radio and parts manufacturing field. And there will be calls for smaller engineering organizations to help share the load in the design and production of defense equipment.

FCC UPGRADING—An industry program should be started to help Washington get a whole FCC organization made up of men who have proven their ability in the field in which they are to serve. At the top this means non-political members. And the commission's staff should be chosen from individuals of outstanding accomplishment, instead of, too often, third-raters who could not hold jobs in commercial companies.

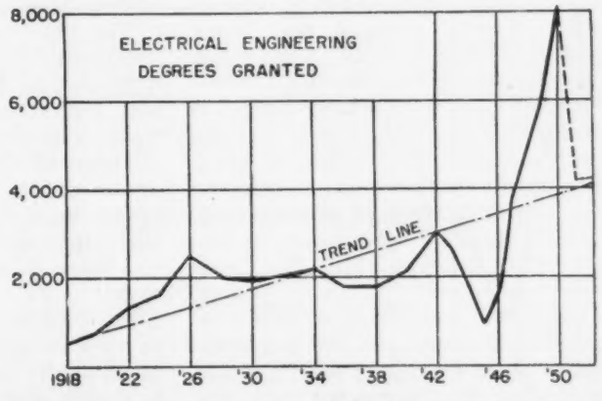
Those who have the responsibility of guiding this great nation's use of the billion-dollar radio spectrum should be the best men we can get. Only in this way can be safeguarded the future development of the field in which we are all so vitally interested and concerned.

PRINTED CIRCUITS COME SLOWLY—The cold logic applied by radio receiver designers in analyzing the future of printed circuits shows an encouraging situation of slow but definite progress in some cases. However, the general conclusion still seems to be that there is no immediate need for having more or less (generally less) completely formed sets issuing every few seconds from a printing press or a plating bath. This is largely because competent designers continue to have the odd habit of using a lot of values of capacitors, resistors, etc., in a circuit!

INTERNATIONAL EXCHANGE OF RADIO ENGINEERS—With the Anglo-US exchange of workers in fluorescent lamp factories earlier this year, a new trend in international relations may have started. The stimulus of an interchange of engineering thought in the field of radio and TV should benefit both countries. For the British; US Methods of mass production would be an eye opener, although not as striking as before the joint war effort reduced national differences. And some US manufacturers could learn from the solid, built-to-last construction of their British counterparts. In the prewar years radio manufacturers in England often engaged men from abroad to work in their labs for a year or more at a time. However, to the best of our knowledge the *exchange* of opposite numbers has never been performed. We believe it would pay off, not only in increased understanding of mutual problems, but in helping those designers in both countries who sometimes "can't see the woods for the trees"!

LET MUSCLE-EMF'S DO THE WORK!—One of the most intriguing results from an investigation of body potentials (associated with the so-called "action currents" spontaneously generated by the muscles when active) is the possibility of using those potentials to operate servo-mechanisms. For example the roving eyes of our inquiring photographer are controlled by the eyeball muscles. It has been shown that the very act of turning one's eye produces muscle potentials which might be used to control a servo to direct a camera to the point being looked at. This may be the start of really simplified living. Why use muscles to do work when all that is needed is their electrical by-products. When that era comes, the difficult part, we assume, will be the tedium of getting "wired-up-for-work" at the start of each standard two-hour work day!

E. E. GRADUATES PEAK IN 1950—Next year will see the top output of engineering graduates in the electrical and radio fields, according to records compiled by the American Society of Engineering Education. Of the total E. E. diplomas, over three-quarters will be in the



communications and radio fields. The great glamour of television, radar and electronic equipment early captivated as high as 90% of the registrants in some colleges, —pointing to a coming excess of communications job-hunters, while the "heavy-current" power utilities continue begging for trained men.

Report on FCC Color TV

Commissioners at the color television hearing in Washington, D. C. Photo shows, from left to right, Commissioners Sterling, Webster, Walker, Chairman Coy, Jones and Hennock. Messrs. Plummer (FCC Engineer) and Plotkin (FCC Attorney) can be seen in the foreground

Highlights of FCC Color Hearings and demonstrations to date, including a tabulation of characteristics comparing the various competitive systems

COLOR television has already involved the expenditure of millions of dollars on the part of several groups, and when a single company can lay claim to having spent over $3,000,000 to develop and promote a color system, as CBS has done, plans for its commercial use are not lightly dropped. This, in a nutshell, is the reason for the present FCC hearing on color television.

Following in the footsteps of Baird in England the sequential field method, using rotating discs to produce color images was early tried by Philco, CBS, RCA and many others. But it was in the laboratories of CBS, with a large technical staff under the leadership of capable Dr. Goldmark, that intensive work on this one system brought it to the near-ultimate stage of development. In this stage it was shown at the 1947 FCC color hearing. The Commission judged it unacceptable. Within the limitations of the proposed CBS standards the performance (picture quality) which would allegedly be demanded by the American audience of the future could not be obtained.

Recent Developments

CBS then reduced the tempo of its color developments, saying that its management had no desire to push the project. However, in 1949 they demonstrated publicly the same system,* altered slightly to show 405 lines, 144 frames, interlaced 2 to 1, in a 6 mc channel. It compared well, in the writer's opinion, with picture quality previously obtained using a 12 mc channel. The best resolution read from a test chart was 190 lines, compared with 320, or better, from standard 525 - line monochrome transmissions.

The showing of pictures in full color—and they are gorgeous and dramatic to the non-scientific person witnessing them for the first time—caused such men as Senator Johnson of Colorado, Commissioner Jones of the FCC and others to agree with various columnists in their theme: "We want color and we want it now!" A hue and cry arose as to "Who is holding back color?" Insinuations were made that, in view of very satisfactory sales of black-white receivers, radio manufacturers wished to hold back color for selfish business reasons. Some thought TV broadcasters, striving to turn their losses into profits, were blocking the inception of color. Repeated questioning, however, by two Commissioners during this hearing did not bring obstructionism to light.

When, in response to alleged "public demand" for color, the FCC gave notice that at this hearing they would consider proposals for commercial broadcasting of color, it is probable that the development work on the RCA system of color, which was shown in its early form at the 1947 hearing, was speeded so as to show it to the Commission in its new, 6 mc channel form.

RCA Color System*

Only the features new to television engineers will be discussed briefly in simplified form. The output of the television camera is reproduced as a 12 mc simultaneously scanned picture in the control room. Here it is fitted into a 4 mc video band (which, with sound, is broadcast in a 6 mc channel), by the process of *Sampling* and by *Multiplex* transmission, as used in telegraphy. On the receiver screen color images are produced with enhanced detail due to *Dot Interlace* and *Mixed Highs*.

Sampling is carried out by employing an extremely narrow pulse to ascertain the amplitude of, say,

*Color Television Transmission Systems, p. 18-20, Tele-Tech October 1949

Demonstrations at Washington

the green signal every 0.263 microseconds. This information and that concerning the other two colors can be successfully conveyed to the receiver by multiplexing so that, with a considerably reduced bandwidth, a reasonably exact facsimile of the original picture is reconstructed. The multiplex "commutator" at both transmitter and receiver is rotated at a 3.8 mc rate. Some of the earlier Am. T. & T. coaxial TV cables pass frequencies up to only 2.7 mc.

Until these are widened to 4 mc they will not transmit an RCA picture in color.

Line interlace in TV pictures is well-known. It is also possible to interlace picture dots along the horizontal scanning lines by reproducing on the first scan only every other dot, leaving spaces in which the dots reproduced on a subsequent scan will fall. In the resulting picture, the usual horizontal line effect will be crossed at right angles by the dot interlace pattern. This gives the large areas of the image a "texture" effect. The important result of using this method is the gratifying increase in picture detail. Under ideal conditions, as shown in the Philco Research Laboratories the introduction of dot interlace increased the resolution seen on a test chart by more than 80%, other factors being the same. RCA slightly increases the width of every other horizontal sync pulse by modifying its trailing edge, so as to cause the dots to interlace when successive lines are scanned. This modification requires no change in wording in the present FCC black-white transmission standards.

Mixed Highs

It has been found advantageous, for instance when using a flying spot scanner, to transmit the lower half of the video band, up to 2 mc, in color and to insert the fine detail as "mixed highs" in black-white. The eye does not perceive the difference.

CBS is to be congratulated upon their excellent demonstration of color TV on Channel 9, both from the studio and outdoors. It was well carried out as to subject matter, equipment and smooth operation. Certainly the FCC was shown this system performing at its best.

RCA's demonstration was disappointing. After learning of RCA's new technical advances we expected much. But there were many things wrong. Most of them could be charged to lack of opportunity and time to get the equipment at both ends of the link working correctly. Only one receiver was bright enough (25 ft. lamberts) to be pleasantly viewed under rather difficult conditions. Color fidelity on all sets was poor; the subject matter not very good; the multiplicity of receiver types was confusing, and the resolution shown was considerably below 200 lines. Two important points however were proven; (a) The principle of the system is sound, regardless of early apparatus difficulties and (b) the RCA system is 100% compatible with the standard 525-line black-white system.

Compatibility

With 3,000,000 TV sets in the hands of the public by the end of 1949 *Compatibility,* that is, the reception of the new color signals in monochrome on present receivers, is of prime importance in the FCC's decision. The industry, through the RMA, stressed this point, The RCA system and that proposed by Color Television, Inc.* give 100% compatibility. Proposals of the latter company have been omitted here because the main contestants are CBS and RCA. CTI will demonstrate for the FCC Nov. 28-30 in San Francisco. Comparative, side-by-side, tests of the CBS and RCA systems, together with black-white pictures to be furnished by DuMont, will be carried out in Washington the week of Nov. 14.

(*Please turn to next page*)

Fig. 1. Three tube RCA color camera demonstrated by Richard Webb, RCA engineer

TABLE A — COMPARISON OF COLOR SYSTEMS

	Horz. Dots Per Line	No. of Vert. Lines	Frame Flicker		Interline or Interdot Flicker		Picture Quality when C is recd. on M set	Compatible
			M	C	M	C		
PRESENT SYSTEM 6-mc Monochrome 30 frames, 60 fields	507	525	Equal	—	Equal	—	Equal	—
CBS SYSTEM 6-mc Sequenital Color	C 275 M 275	C 405 M 405	Inf.	Inf.	Equal	Equal	Inf.	No
COLOR TELEVISION, INC. 10 Color pictures. 50 fields Simple interlace plus color line commutation	C 507 M 507	C 525 M 525	Equal	Equal	Int.	Inf.	Inf.	Yes
RCA SYSTEM 6-mc Seq. dot, Color 15 color pictures, 60 fields Dot & Line interlace	C 507 M 507	C 525 M 525	Equal	Equal	Equal	Equal	Equal	Yes

KEY. C Color
M Monochrome
Inf. Inferior

NOTE. This chart is based mainly on data reported by the Joint Technical Advisory Committee (IRE-RMA) to the FCC. Dockets 8736, 8975, 9175, 8976.

FCC TV COLOR (Continued)

At this time with the hearing still in progress no one knows what the outcome will be. There is a demand for early "guesses" as to its outcome, so the reader realizing that what follows is in the "guess" category, the possibilities that face the FCC may be considered. The Commission may:

(1)—Adopt the CBS Standards. Reasons For: It is ready; the color picture is usable; converters are low in cost; political pressure to adopt this system and to start color service now is great. Reasons Against: System is not compatible without alterations on present receivers; picture performance low, lower than present monochrome; mechanical rotating disc used; TV industry does not want inferior system standardized.

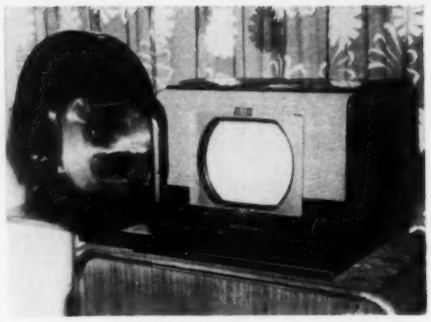
(2)—Adopt the RCA System. Reasons For: It is 100% compatible, color transmissions give monochrome equal to black-white with no changes in receivers; it is the only system that promises color pictures of quality equal to present black-white images, only of course with color added; based on technical features it is the choice of the majority of the industry's television engineers. Reasons Against: It is complicated; at present requires three picture (projection) tubes for good color, (invention of single tube would reduce cost and ease conversion problem); it has registration problems; it is in an early developmental stage, requiring probably a year before it is ready commercially.

(3)—Send Color back to the Laboratory. Reason For: A simple, 6 mc, low-cost system giving performance equal to present monochrome and 100% compatible has not yet been developed. RCA has made notable contributions in this direction during the past 10 months by introducing dot interlace, sampling and multiplex transmission. Reason Against: Pressure on the Commission to approve color broadcasting brought by those who do not appreciate the basic technical facts in the case.

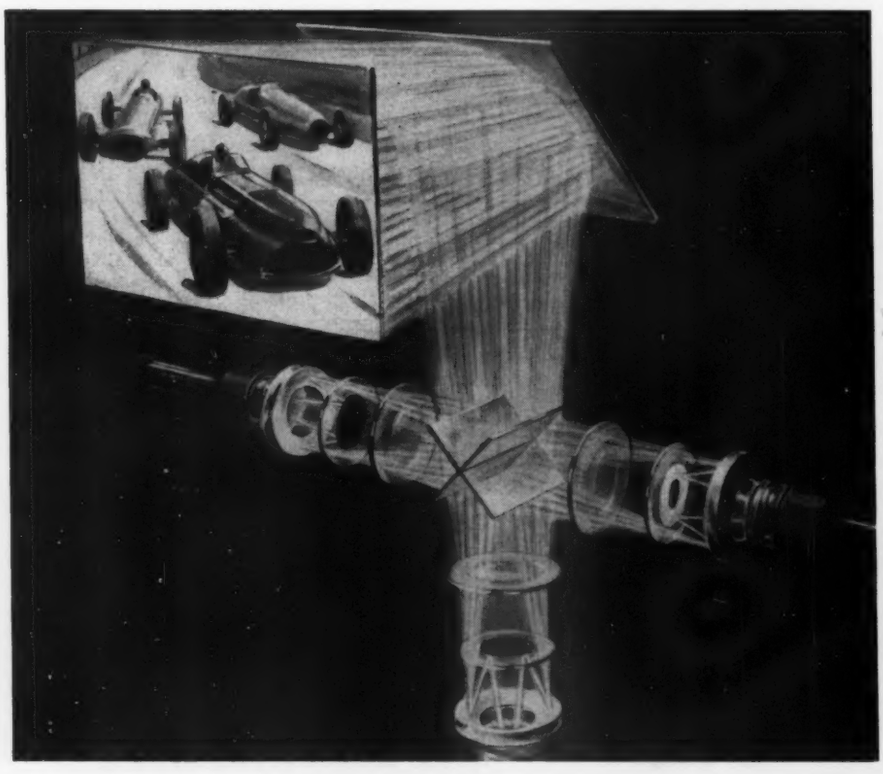
Lifting the "Freeze"

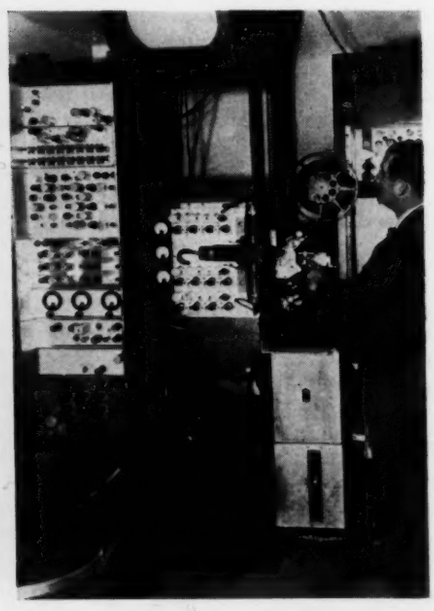
The whole television industry is asking the FCC to end the "freeze" which has stopped the issuance of construction permits for TV stations. If the Commission, after hearing the testimony, can decide that satisfactory color pictures can be broadcast in a 6 mc channel, then the ban can be lifted, UHF allocations made, and the matter of color standards settled later. If, on the other hand, a wider channel, say, 12 mc, is required for high-fidelity color (and such a picture was shown by Mr. Keel to visitors, including the FCC, in the control room at WNBW during the RCA demonstration), then the allocation of the UHF band should be made accordingly.

"What would you do?" Many of the witnesses were asked this question by one of the Commissioners during this hearing. After witnessing the demonstrations and listening to the testimony thus far, it is felt that 6 mc channels should be approved for color; the freeze should be lifted; the color systems be sent back to the laboratories and reports of progress should be requested every 6 months. When the present difficulties and shortcomings are overcome the FCC should request the TV industry to meet and draw proposed technical standards for color for the FCC's approval. Such engineering standards should be firmly based on engineering facts and these alone. This was the manner in which our present monochrome standards were formulated. Will the industry permit political pressure to dislodge, distort, destroy this firm technical base?



CBS color converter moved away from front of the receiver to show ease of changeover





(Left) RCA projection set uses three kinescopes, reflective optics, and a pair of dichroic mirrors to produce color pictures (Below) Three tubes are required for full color pick-up from the 16 mm projector. The electronic sampler unit is shown at left

Glossary of Terms Used in Color TV

Presented below is a list of terms which are becoming increasingly common in the field of television and more particularly in color television. Tentative definitions are suggested for some of the newer terms.

Adaptability

A feature of a proposed color television transmission system which makes its use possible with existing receivers to obtain monochrome—or color-pictures only.

Adder

An electronic device in which electrical signals are combined to form a composite signal. Example: Combining samples of colors of the televised scene with the horizontal sync pulses.

Additive Color

A system which combines two colors to form a third.

Compatibility

Ability of color television transmission system to provide color service for modified or special color receivers and still produce monochrome pictures on existing receivers without modification.

DC Component

A term used to designate electrically the average brightness of the scene being televised, as distinguished from the extreme highlights and shadows.

Dichroic Mirror

A glass surface treated with metallic salts which exhibits the property of reflecting only one color and absorbing all others.

Dot Interlacing

A method of placing dots of colors on a television screen to form the complete picture. During the first scanning of each color, the dots are separated by approximately their own width, and on the following scan of the same color, the dots are placed to fill the spaces in between.

Electronic Commutator

A switching arrangement composed of electron tubes and circuits used to connect circuits in rapid succession. At the color television transmitter, the commutator samples each of three colors in a specified order. At the receiver, the commutator routes the three color signals in proper order to three kinescopes.

Field

The partial image which results from a single scanning of green, red and blue lines from top to bottom of a picture.

Line Interlacing

The standard system of picture scanning in which odd-numbered lines are scanned as the first field and even-numbered lines being scanned as the second.

Mixed-High Frequencies

The portion of the television color signal which carries the finer (higher frequencies) details of the transmitted image.

Picture Dot

The basic—or picture element—area of each color pulse. In the RCA color system, there are 3,800,000 pulses for each of the three primary colors every second.

Reflective Optics

A system in which the rays of light are reflected as in the Schmidt system of projection.

Refractive Optics

An optical system in which the light focusing is performed by a

(*Continued on page* 61)

Circularly Polarized Airport Antenna

CIRCULAR polarization for aviation ground station use appears to offer considerable advantage over the conventional type of radiator. By the use of circular polarization the orientation of the antenna on the airplane is not critical. Also, it provides continuous communication even when the plane is making a sharp bank that might cause a momentary dead spot in communication using plane polarized antennas.

It is also possible that this type of polarization will effect an improvement in many cases of dead spots in mobile communication. A number of manufacturers and equipment users are investigating its possibilities and it is probable that in the future it will become much more popular. It has, of course, been tried in connection with FM broadcasting and produced encouraging results.

The illustration shows a typical circularly polarized antenna made by the Andrew Company of Chicago, Ill. This particular antenna was made for the CAA for use in plane to ground communication at approximately 120 MC.

The four inclined loops at the top of the antenna are the actual radiating elements. Their dimensions and orientation are so designed as to provide vertical and horizontal components of field that are at quadrature phase relation with each other. Immediately below these loops is a quarter wave choke, with the open end upward. This choke acts in conjunction with the four ground plane rods to suppress any radiation currents that might flow on the supporting mast and thus upset the radiating properties of the system. The coaxial line feeding the antenna is routed up through the supporting mast.

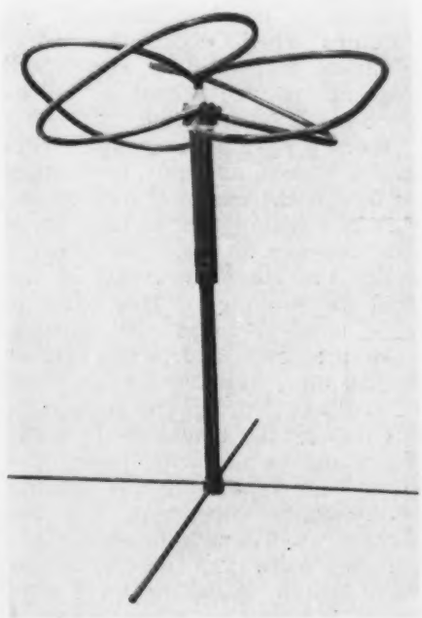


Photo of circularly polarized antenna designed for 120 MC aeronautical use. Reports on its use for FM broadcasting are encouraging

Duplication of Magnetic Tape

New "copying" method requires no electrical transcription. quality indicates large scale producton of pre-recorded

By **ROBERT HERR,** *Research Dept., Minnesota Mining & Manufacturing Co., St. Paul 6, Minnesota*

THE magnetic recording art in the past has had one serious limitation in that no convenient method has been available for producing a number of copies of a recording without actually playing it back and re-recording it on another tape or several tapes simultaneously. This paper describes a new method of copying magnetic recordings which does not involve electrical transcription and which does not require record or reproduce heads of any kind.

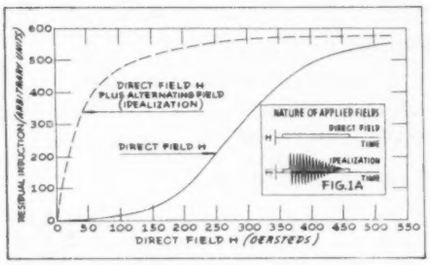


Fig. 1: Curves illustrating the effect of idealization on residual induction

When a recorded magnetic medium is placed adjacent to another section of the medium, such as occurs in a reel of wire or tape, there is a tendency for one layer to magnetize the other by virtue of the field surrounding it. This effect is very small because the existing fields are small, and in the case of coated tape, these fields are further attenuated by the separation afforded by the nonmagnetic backing acting as a spacing layer. The attenuation caused by this spacing is frequency dependent, and the shorter wave length fields are attenuated more than those of longer wave length. Also, the level of a signal impressed on the adjacent tape in this manner does not vary linearly with the level of the recorded signal because of the highly non-linear remanent magnetization characteristic of all magnetic recording media.

This characteristic is depicted graphically by the solid line in Fig. 1. The numerical values differ somewhat among various tapes in use, but the value shown for a γ-Fe_2O_3 oxide of coercive force 240 oersteds may be considered typical in nature. The curve shows on an arbitrary vertical scale the induction remaining in the material after a sample has been demagnetized and then subjected to unidirectional fields of various strengths. Since the fields existing in the neighborhood of recorded tapes are of the order of 50 oersteds it can be seen that the degree of magnetization resulting from placing a demagnetized tape next to a recorded tape will be very small and also non-linear.

This magnetization, however, may be enhanced and made linear by the so-called "idealization" process. The shaking or idealizing influence may be almost anything which introduces strains into the crystal lattices of the magnetic material. Elevated temperatures, electric fields, magnetic fields, X-radiation, and mechanical stresses may all be used with varying degrees of effectiveness. Magnetic fields, however, seem to offer the simplest and most easily controlled form of idealizing influence.

Idealization by Magnetic Fields

For idealization by magnetic fields an alternating field is superimposed on the print tape along with the direct field of the recorded magnetic tape. This alternating idealizing field preferably will have maximum values sufficient to magnetize the magnetic material of the previously printed tape nearly to positive and negative saturation for a few cycles, and then gradually reduce over the course of many cycles to zero. For this case of idealization by magnetic fields, the characteristic of remanent induction as a function of the direct field is shown in Fig. 1 by the dashed curve. To make the idealizing process clear, the history of the sample in terms of applied field vs. time is shown in the inset, Fig. 1A, for both the dc and the idealized case. The curve for idealization may be generalized considerabiy; it is shown as though the alternating component begins abruptly at maximum strength whereas it may increase gradually to maximum strength and will in practice do so. Also, the alternating component may have any orientation in space relative to the direct field; and for random orientations, which may in fact change with time, the conditions are hard to depict graphically. The alternating field for idealization of a sample of the tape shown in Fig. 1 should have maximum values of the order of at least 250 oersteds and preferably more. The curve shown is for 500 oersted maximum idealizing field. The use of smaller idealizing fields will result in characteristics lying between the two curves shown.

It will be readily seen that in this process the idealizing field may increase the residual induction caused by a given direct field by a factor, depending on the strength of the direct field, as much as 40 to 60 db. Thus, although ordinarily signals produced in a demagnetized tape by face to face contact with a recorded tape are inaudible or at the most at about the noise level, this process is capable of increasing such signals to approximately full

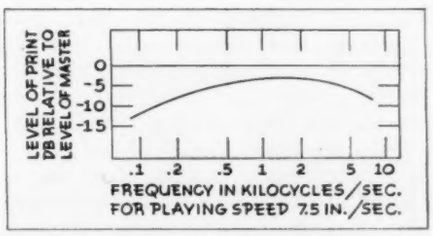


Fig. 2: Efficiency of the printing process

Recordings by Contact Printing

Simplicity, speed of the operation, and resultant audio program material practical from an economic viewpoint

modulation of the magnetic medium. It may also be seen that the residual induction is very nearly proportional to the direct field over the region of small fields, so that the recorded signal on one tape may be reproduced on the adjacent tape without appreciable non-linear distortion.

In order to prevent severe high frequency discrimination, the magnetic surfaces of the two tapes should be placed in close contact. In this way, provided there is no relative slippage of the tapes during the "printing" process, high frequencies of wave lengths as short as 0.001 in. (7500 cps at 7.5 in./sec.) may be duplicated with only about 3 db loss relative to the duplication of a medium wave length signal. There is also a loss of several db at very long wave lengths that depends upon the tape used and idealizing field strength.

Fig. 2 shows the level of printed notes relative to the level of the master record as a function of frequency. These data were taken using the medium described by Fig. 1 with an idealizing field of about 300 oersteds maximum. (Slightly better results may be obtained using still larger idealizing fields.) It should be noted that these data are for a tape speed of 7.5 in./sec. and are plotted as a function of frequency, but that the phenomenon is essentially dependent upon wave length rather than frequency. The drop in efficiencies at low frequencies is apparently inherent in the process but at high frequencies intimacy of contact, freedom from relative tape slippage, head alignment, etc. are the controlling factors. Still better machines than the one on which data for Fig. 2 were taken may show even less loss of high frequencies.

The losses involved in this way of printing are small but definitely significant. Duplicates made without any special recording of the master will be easily intelligible and fairly satisfactory, but they will never be the equal of the master record. The frequency selectivity of the process may be compensated by appropriate equalization in recording the master or in playing the print, but only at some sacrifice of signal-to-noise ratio.

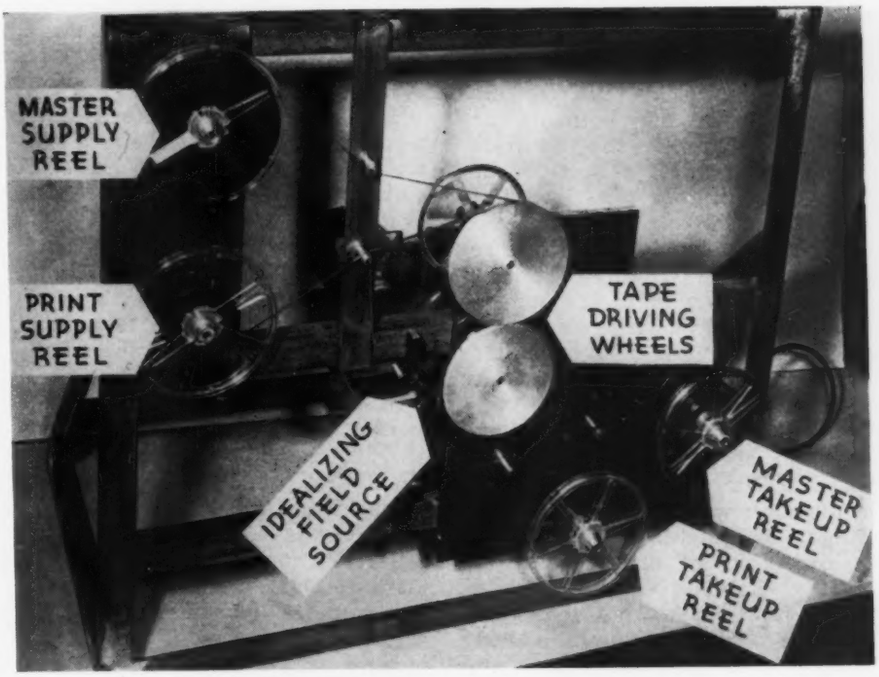


Fig. 3: Experimental machine for making a single tape duplicate. The tape speed is 10 in./sec. and peak idealizing field strength is about 300 oersteds at 600 cps

Another step may be taken, however, that increases the quality of the print considerably. It is not necessary for the tape used as a master to be identical with the tape used to run off duplicates. Tapes differ in their inherent signal level and without going to a tape superior in signal-to-noise ratio it is possible to select one which has higher absolute levels. In this way the print tape, although modulated to a lower absolute level than the master, may be fully modulated to its own distortion point. The only loss then remaining is that occasioned by the frequency selectivity, assuming the master and print media have similar frequency responses.

While it is possible to use either special master or special print media or both, special print media have so far been avoided in order that a pre-recorded reel of tape could be satisfactorily be erased and reused on existing recording machines. On the other hand, a special type of tape for masters would not be impractical. For example, a tape with a very heavy coating of magnetic material may be utilized to obtain a better low frequency response with very little or no increase in noise, which still further decreases the need for bass equalization. In general, it is possible with existing media to obtain a print with no frequency distortion at a level from 5 to 7 db below that obtainable by direct recording, or alternatively some compromise between higher level and flat frequency response may be struck. With media which can be foreseen, no sacrifice in level or frequency response will be necessary.

It is worth noting that not only is the signal level of a print the same or nearly the same as that which can be obtained by direct recording, but the noise is, if any-

(*Please turn to next page*)

MAGNETIC TAPE DUPLICATION (Continued)

thing, less. In direct recording there is always some contribution to noise by the imperfect demagnetization achieved by the erase head or the modulation noise created by the bias field. In printing, the roll of tape may be initially demagnetized very carefully by large external demagnetizing fields, and the only noise will be the actual modulation noise of the recorded audio signals, which is inevitable. While in theory and in some laboratory equipment, the noise caused by imperfect erasure and biasing may be made vanishingly small, in practice the background noise level of a truly demagnetized roll of tape is usually at least several db lower than that of tape erased and biased by a recording machine. In any event, it is a great deal easier to demagnetize rolls of tape by a large solenoid or electromagnet than to maintain nearly perfect recording heads, bias supplies, etc.

There is another reason that the selection of proper media is important. The discussion above on idealization was based upon idealizing fields added to a dc field which is invariable. In printing, this dc field is the field of the recorded master tape and it is not necessarily invariable. In duplication, the idealizing field is only wanted in the region of the print, but with the print and master in contact, the master recording necessarily is subjected to some alternating field as well. This alternating field, if large enough, may partially erase the master recording. On the other hand, if the idealizing field is too small, the print will be low in level, especially at low frequencies, and suffer non-linear distortion. Thus in duplicating a recording on another tape of the same magnetic material, a compromise level of idealizing field is sought which gives the best overall results. (If some erasure of the master results, it occurs only once, in making the first duplicate; subsequent applications of the same idealizing field do not attenuate the master further.)

It may be seen therefore that a medium designed to serve as a master should be difficult to erase. To serve as a print it should be capable of idealization with a relatively low alternating field. These two conditions are in rather essential conflict and it seems reasonable that printing from one tape to another identical tape will never be wholly satisfactory.

In connection with harmonic distortion; this process is excellent provided sufficiently high idealizing fields are used. In general, harmonic distortion caused by the reproducing process has not been detected. To the extent that there is slight frequency selectivity, particularly in the low frequencies, the harmonic content of a master recording will be reproduced at a slight increase with respect to the fundamentals. For example, Fig. 2 shows the transfer efficiency at 1200 cps to be about 2.5 db higher than at 400 cps, so that a 400 cps signal recorded with 1% third harmonic distortion will be reproduced with about 1-1/3% third harmonic distortion, assuming the same playback equalizations. If the frequency response differences between master and print are compensated by post-equalization of the print rather than pre-equalization of the master, this effect is nullified.

Some of the many advantages of duplication by this printing process are:

1) Simplicity: The machine for duplicating, except for an ac electromagnet source, is all mechanical. There are no critically adjusted heads to wear out, low-noise high-gain amplifiers to build or maintain, etc. It may be operated by unskilled personnel.
2) Mechanical problems are minimized. The speed need not be constant as in a reproduce-re-record machine. The only stringent mechanical requirement is that the two tapes be kept in contact without sliping while they are in the idealizing field.
3) Speed is unlimited. The speed of duplication in a reproduce-re-record machine is, depending on the frequency range of the recording, at most two or three times the playing speed of the tape. In this process, the speed of reproduction is not related to the playing speed.

The tape speed factor deserves some amplification. The basic requirement of the process is that the tapes in contact be in the idealizing field for a few cycles at maximum strength plus many, preferably a hundred or more, cycles of gradually decreasing strength. This decrease is, of course, effected by allowing the tapes to move out of the field of the magnet while they are still in contact. The speed, therefore, may be increased by increasing the frequency of the idealizing field, or by increasing its physical dimensions, or by a combination of the two. Experience in this problem has not yet shown clearly the best technic, but it seems preferable to keep the dimensions small so as to minimize the non-slip tape distance and to increase the frequency as necessary for the speed desired.

An experimental machine for making a single tape duplicate is shown in Fig. 3. The two tapes from supply reels in the upper left are fed together over the two drive reels in the center to slipping

(*Continued on page* 57)

Fig. 4: Portable demonstration duplicator. Tape speed is about 20 in./sec. with a 2 KC idealizing frequency. Field is directed transversely with respect to tapes

Improved Radio Systems for Modern Aircraft

New developments incorporate many 1947 PICAO recommendations. Full use of DME expected by 1953

IN March 1947, Tele-Tech published a chart giving the salient features of the radio aids to navigation approved by the Provisional International Civil Aviation Organization (PICAO). These devices having been approved by the representatives adoption was necessary by the countries concerned. Most of these have now been adopted either in the original, or a modified and improved form. In a number of foreign countries, notably Great Britain, many of these installations are in very successful operation. That country, and many others have purchased considerable quantities of radio equipment from the U. S. to implement their air navigation and communications planning. This article reviews the progress made in developing the apparatus and presents details of the various equipments, together with information concerning the latest developments in the civil field in the United States.

Unfortunately the current military situation is not open to discussion owing to security regulations. One of the problems in this field which no doubt is receiving attention is that of interference due to Doppler effect in high speed jet aircraft. This effect has been used to measure the ground speed of aircraft with some success by both RCA and Federal Radio. In the RCA equipment a 400 MC pulse with a power of 15 kw and a repetition rate of 15,000 pulses per second was used. The signal is transmitted in both front and rear directions with separate receivers for each direction. The phase relationships of the received signals is compared, and after filtering the resulting voltage applied to a frequency counter-calibrated in terms of miles per hour.

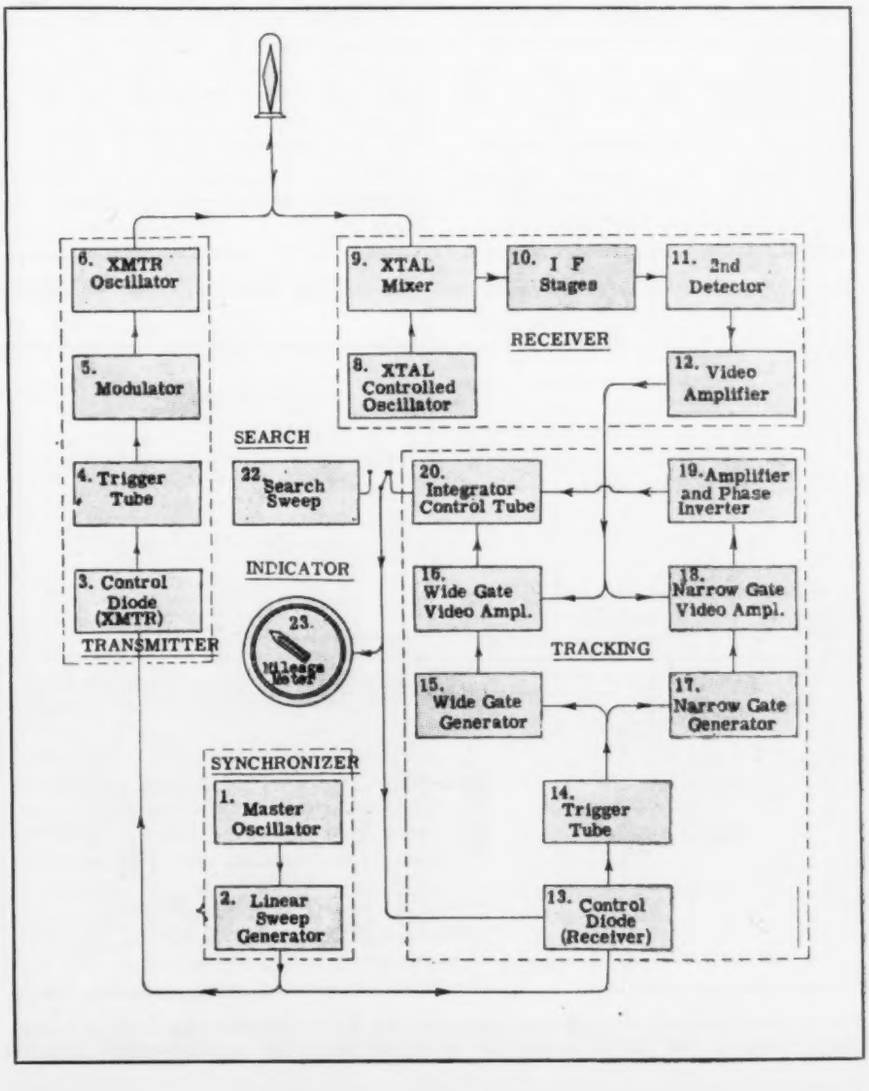
The program envisaged by PICAO has been implemented and a number of new facilities added. The illustrations show the essential data of many of those already in operation, and details of proposed and new equipment is given in the body of this article.

Radio Compass AN/ARN-6 is designed to guide aircraft to a transmitting station at its destination or take bearings on transmitting stations as an aid to navigation. An indicator continuously indicates the direction of the transmitting station with respect to the aircraft heading. While the equipment is being used as a radio compass, the pilot and navigator can also hear the station signals and thus obtain weather reports or other flight information. In addition, it may be used as a radio communication receiver.

In operation a directional loop receives a signal, the phase of which is retarded ninety degrees and then fed to both grids of a dual-triode used as a balanced modulator, with 100 cycle push-pull modulation. The modulated signal is combined with the signal from a sense, or non-directional, antenna, and the results applied to the input of a conventional superheterodyne receiver. The detected signal is fed to two independent output circuits, one for listening and the other for

(*Please turn to next page*)

Fig. 1. Block diagram of airborne Distance Measuring Equipment now reaching perfection



automatic control of the loop drive motor. The position of the loop is remotely shown on indicators and gives the bearing, in degrees, of the transmitting station.

The Homing Adapter AN/ARA-8 has been developed to provide a means for aircraft to home on any carrier within the frequency range 120-140 MC. Operation is based on the principle of phase difference reception by two antennas. Coding is introduced by the receiver so that any transmission can be used and a special transmitter is not required for this equipment. This makes a standard VHF omnidirectional range serve a double purpose.

Air traffic control is one of the most pressing problems of today, and many solutions have been offered. One suggestion which seems to offer prospects of easing the strain on pilots and ground personnel in the areas surrounding airports is Teleran, produced by RCA. In this system the air surrounding the airfield is scanned by radar and the information presented in the usual manner to the controllers. It is also scanned by a flying spot scanner and transmitted to all aircraft in the vicinity. Thus, every pilot has a picture of the position of his aircraft, and the other traffic in his vicinity. The heart of this system is the Graphecon, an RCA developed tube which both reproduces the radar scan, scans it in turn and transmits it to the aircraft.

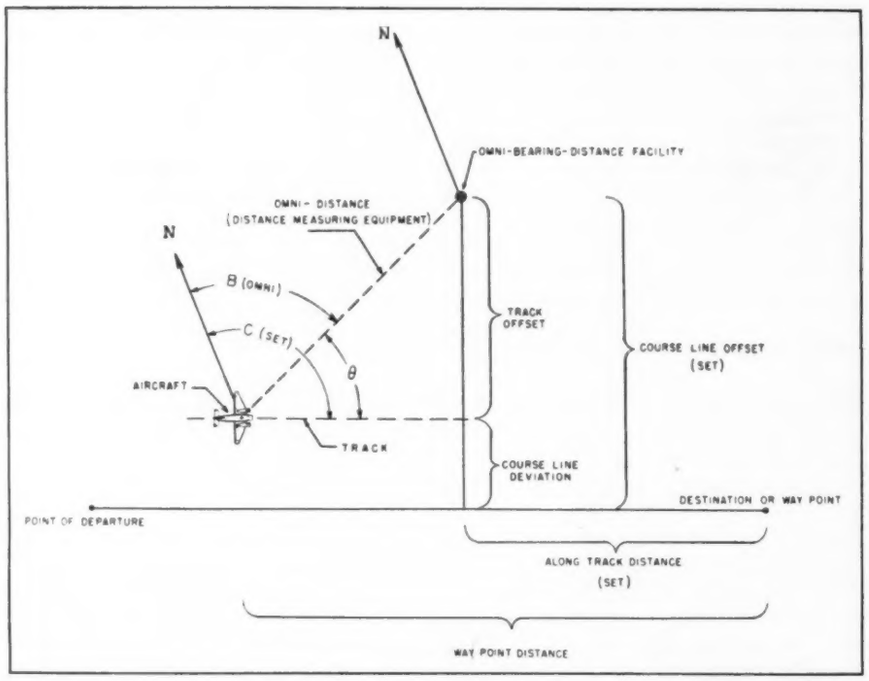


Fig. 2. The mathematics of the course line computer are relatively simple trigonometry

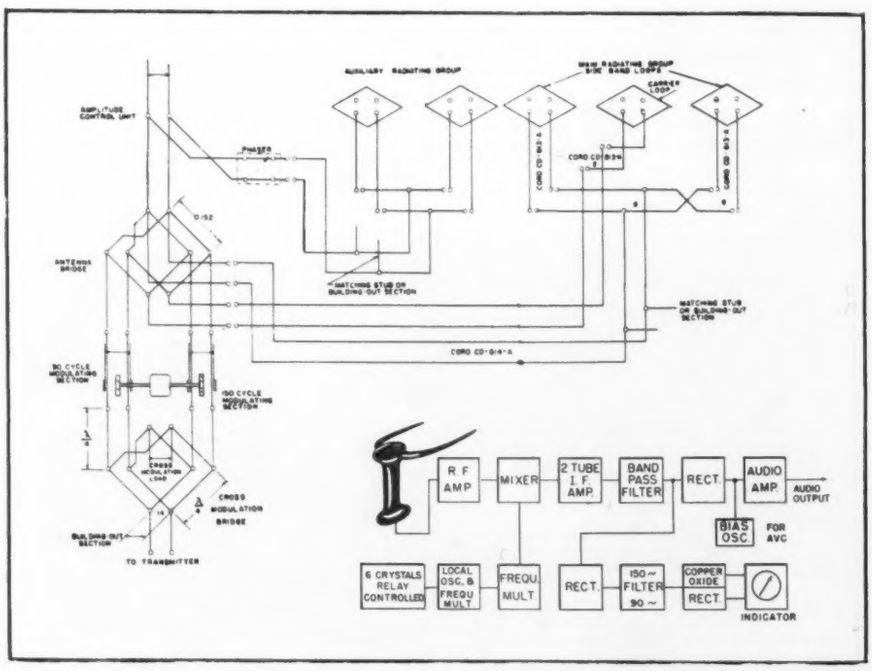


Fig. 3: (Left) Diagram of mechanical modulator for ILS transmitter and antenna system. (Right) Localizer for ILS is a six-channel crystal controlled superheterodyne receiver

Distance measuring equipment used in conjunction with ILS and VHF in omnidirectional ranges provides a method of navigation which removes a lot of the hard work from the navigator's job. DME operates on the principle of measuring the time lapse between transmission and reception of two signals. A pulse is initiated by the airborne transmitter. This triggers a responder beacon which transmits a replying pulse after a standard minimum delay period. The time difference between the time of transmission and reply is measured and presented in terms of distance. Two systems of DME have been combined to form a transition period system. The chief difference between the two systems is in the method of obtaining the required number of channels. These two systems are described below, both operate in the same frequency band 960 MC. to 1215 MC. and present the formation in the same manner.

Pulse Multiplex System

This DME system combines several operating channels on each pair of radio frequency channels using cross-banding and paired-pulse coding (Modes) to differentiate between the multiplexed operating channels. The channel-to-channel radio frequency spacing is 9.5 MC. Thirteen radio frequencies are provided for interrogation and thirteen for reply between 960 MC. and 1215 MC. Four spacings of paired pulses are employed on both interrogation and reply, which results in a total of 52 operationg channels. The airborne receiver local oscillator and transmitter are self-excited with crystal control or electromechanical automatic frequency control. A spike eliminator is used to sharpen the band pass of the re-

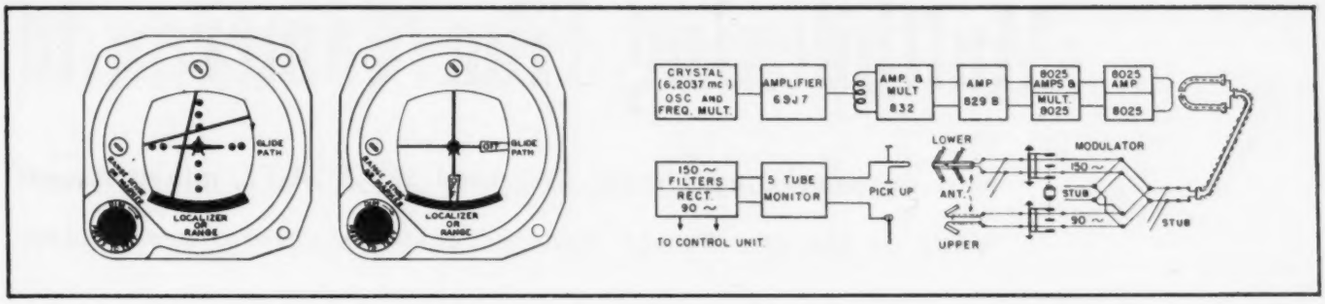


Fig. 4: (Left) ILS indicator. 60 and 90 cps signals operate vertical and horizontal needles. (Right) Transmitter to produce pattern of Fig. 7

ceiver. The ground transponder has its receiver local oscillator and transmitter oscillator frequency automatically controlled.

Narrow Band System

This DME system provides a clear pair of radio frequency channels for each operating channel. The channel-to-channel spacing is 2.4 MC. Fifty-one radio frequency channels are provided for interrogation and 51 for reply between 960 and 1215 MC, which results in a total of 51 operating channels. Single pulses are em-

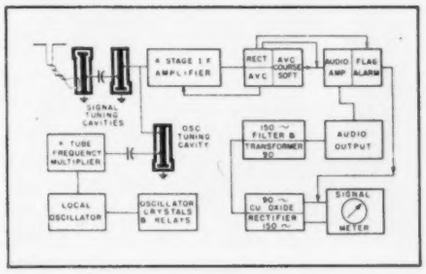


Fig. 5. Glide path receiver operates with 28 volts plate voltage and uses 3 crystals.

ployed on both interrogation and reply. The airborne receiver local oscillator is directly crystal-controlled, while the transmitter is a self-excited oscillator that is held to the same crystal reference by means of automatic frequency control. A special double discriminator circuit is used to increase the adjacent channel rejection of the receiver. The ground transponder is similar in design to the airborne interrogator. Its local oscillator is direct crystal-controlled and its transmitter automatic frequency controlled by reference to a crystal. Fig. 1 is a block diagram of an airborne DME set.

The fundamental principles of the course line computer are given in the accompanying diagram, Fig. 2. The pilot lays down the desired course line. He also selects his destination and starting point along that line. The omni bearing distance facility which he will use is also plotted. He then measures the course "C", the course line offset distance, and the along track distance. The angle θ is the difference between course "C" and the omni bearing "B". The computer multiplies the omni distance by the sine of the angle θ, which result is proportional to the offset of the track the aircraft is flying at the particular instant. The computer subtracts the track offset from the course offset and applies the difference to the course line deviation indicator to provide off-track information. Obviously, if the off-track distance is zero, the aircraft track and course are coincident.

In the actual computer the omni distance is converted to a 400-cycle voltage of approximately one volt per mile. This voltage is applied to a potentiometer whose output is proportional to the sine of its shaft

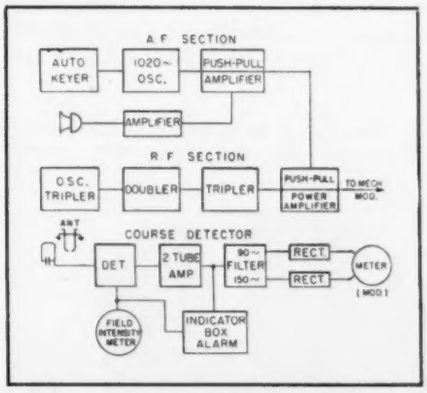


Fig. 6. Localizer transmitter supplying RF to antenna and modulator systems (Fig. 3)

rotation. The shaft of the latter potentiometer is connected to that of a servo driven omni bearing selector, and the housing of the potentiometer can be rotated to correspond to the course heading selected by the pilot. The 400-cycle voltage output of this potentiometer is proportional to the "track offset". Another knob is set and locked by the pilot at the time the course is selected. It controls a potentiometer whose 400-cycle voltage output is proportional to the course line offset. These two voltages are converted to constant currents by series resistors and their difference, which is proportional to the off-track distance, controls the course line deviation indicator through a servo operated potentiometer and a rectifier.

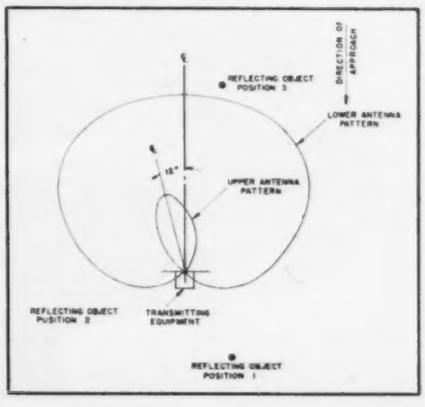
Another wiper on the sine wave potentiometer has a voltage output proportional to omni distance cos θ. A third potentimeter is set by the pilot to produce a voltage proportional to the along-track distance. These two voltages are converted to proportional currents and their sum, which is proportional to the distance to the waypoint, controls a "distance to waypoint" dial through a servo motor. Thus DME and the Course Line Computer, or R/Theta Navigational system, combined with one unit provides the navigator with all the position information he needs.

Automatic Flight Control

Problems of automatic flight control continue to exercise the minds of engineers and have resulted in the development of a new type of ILS localizer. The standard system uses a superheterodyne receiver with 90 and 150 cps filters for sep-

(*Continued on page 59*)

Fig. 7. Horizontal field pattern of glide path indicator. Radiation is offset to overcome the distortion resulting from reflections



Multiplexing Film Cameras to

New quadruplexing system, first used at KECA-TV, allows almost while on the air. Turret mounted cameras rotate through 360°

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&

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SINCE the very early days of television broadcasting, it has been quite obvious that recordings of program material on film would play the same important role in this newest entertainment medium as transcriptions and recordings have in radio broadcasting. In fact, with television-recordings now making possible early expanded network programming, certainly the television film camera and its associated projectors make up a very important keystone in today's television plant.

Bearing in mind the heavy operational burden that is placed on the average telecine installation, the following film-projection room layout requirements have been established by the ABC Facilities Engineering Dept.:

1. Film cameras should be mounted in such a fashion that in case of camera failure, a spare can be brought into service with a minimum loss of time.
2. The arrangement should provide for the operation of a pair of projectors (two 16 mm's or two 35 mm's) individually into a single camera or for their simultaneous operation into two separate cameras.
3. Finally, for maximum flexibility, each camera should be available for use with several different positioned projectors as needs increase.

These general basic requirements, though simple, are obviously important. The second deserves further delineation. A system arranged to meet this need would not tie up two camera chains with the showing of a "feature" film (more than one reel). On the other hand, both projectors could be made available for simultaneous operation into two separate cameras, thereby providing for a maximum utilization of facilities to take care of peak loads brought on by preview-screenings and rehearsals.

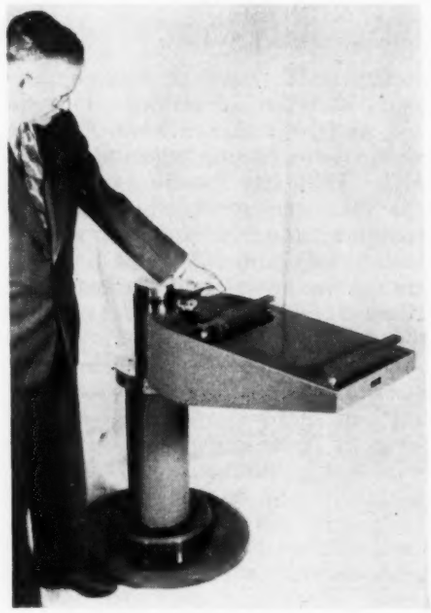


Fig. 1: Photo of turret body showing mounting, leveling bars, and detent locking handle

Fig. 2: Heart of the system, the four mirror diplexer, or quadriplexer. Moving the mirrors to the opposite end of their travel permits operation into either camera

In planning the telecine room layout for KECA-TV in Los Angeles to meet these requirements, most of the industry's existing arrangements were carefully considered along with several variations thereof. A modified version of the RCA mirror multiplexer using four mirrors (two movable pairs) instead of a single fixed pair, combined with a special camera turret mount was finally designed. The first units of this type were built for KECA-TV by Gray Research and Development Company to meet ABC Engineering Specifications. The camera turret shown in Fig. 1 is rotatable through 360 degrees, with four adjustable detent positions spaced nominally every 90 degrees

Minimize TV Program Failures

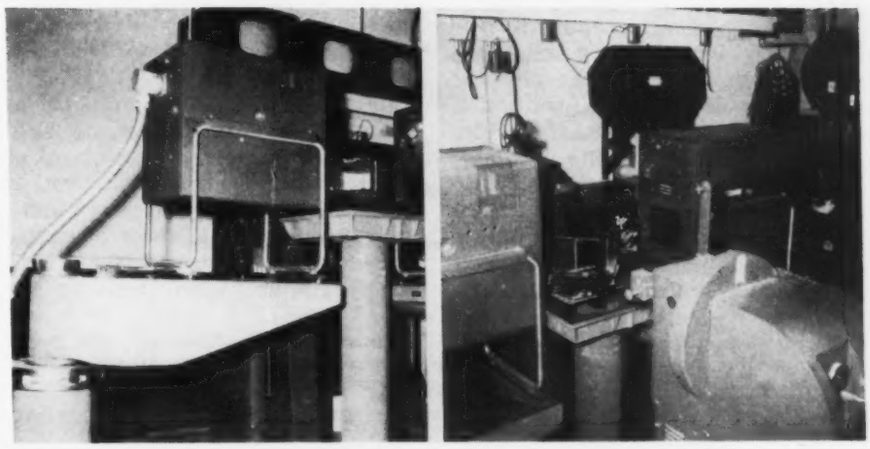
uninterrupted programming in the event film projector fails to effect pickup from any one of four picture sources.

plus or minus 5 degrees.

Cable feed to the film camera would normally be dropped down from a central raceway immediately above the turret mounts. No protection has been provided for twisting of this cable since extreme importance was placed on the desirability of having a limited continuous rotation available. It is assumed that with normal operating precautions, this feature will present no real hazard.

The turret body, mounted on precision machined bearings, swings at the top of a steel pedestal. This turret body is made of light steel sheet metal to lower the center of gravity and to give ease in handling but is of aircraft type construction with welded reinforcing ribs inside to avoid warping and to provide the required rigidity. Azimuth rings, located just below the turret on the pedestal, hold the four detent button segments which, when adjusted in proper quadrants, are locked in place with two set screws each at installation. A plunger, fitting down through the turret, trips over the detent buttons to lock the turret in place without allowing any radial play. The toggle type operating handle for the plunger is readily accessible on the top surface of the turret. In order that the camera may be tilted in any plane for proper operation at the time of installation, two precision ball swivel camera support bars are provided with four jack screws on the top of the turret body. This arrangement permits the raising or lowering of the camera one inch front to rear, side to side or vice versa.

The principal feature of the system is the special four mirror multiplexer shown in Figs. 2, 3, 4. This precision unit conveniently handles the second stringent requirement previously listed. The mirrors shown in Fig. 2 at opposite ends of their travel provide for split operation of two projectors into separate cameras. On the other hand, by merely sliding either one of the two mirrors to the opposite end of its travel, the mirrors are set for dual projector operation into one of two cameras.



Figs. 3 and 4: (Left) Camera mounted on turret shows ease of connection. (Right) Quadriplexer with two projectors and cameras in position. Note economical use of space

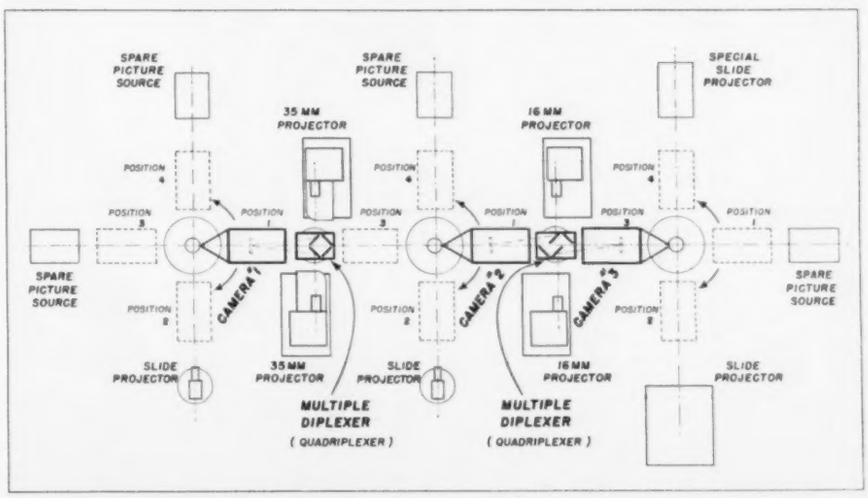


Fig. 5: Floor plan of KECA-TV projection room. Using only three cameras, twelve projector positions are available compared with the nine from a standard installation

Micro-switches built into the multiplexer are used to control an added relay on the standard projector changeover panel. When both pairs of mirrors are at the same end of travel (either end) the control panel operates in normal fashion. When the two sets of mirrors are at opposite ends of the travel, however, the additional relay mentioned above automatically disables the changeover control, opens the closed projector douser and provides two audio outputs.

The body or top plate of the multiplexer is made from a precision ground machinist's surface plate. This plate is fitted with a plug which swivels in the top end of the pedestal and is locked in place with four set screws, to provide radial adjustment at installation. At both ends of the plate are two heavy support bars for slide rods. The latter are precision

(*Continued on page* 64)

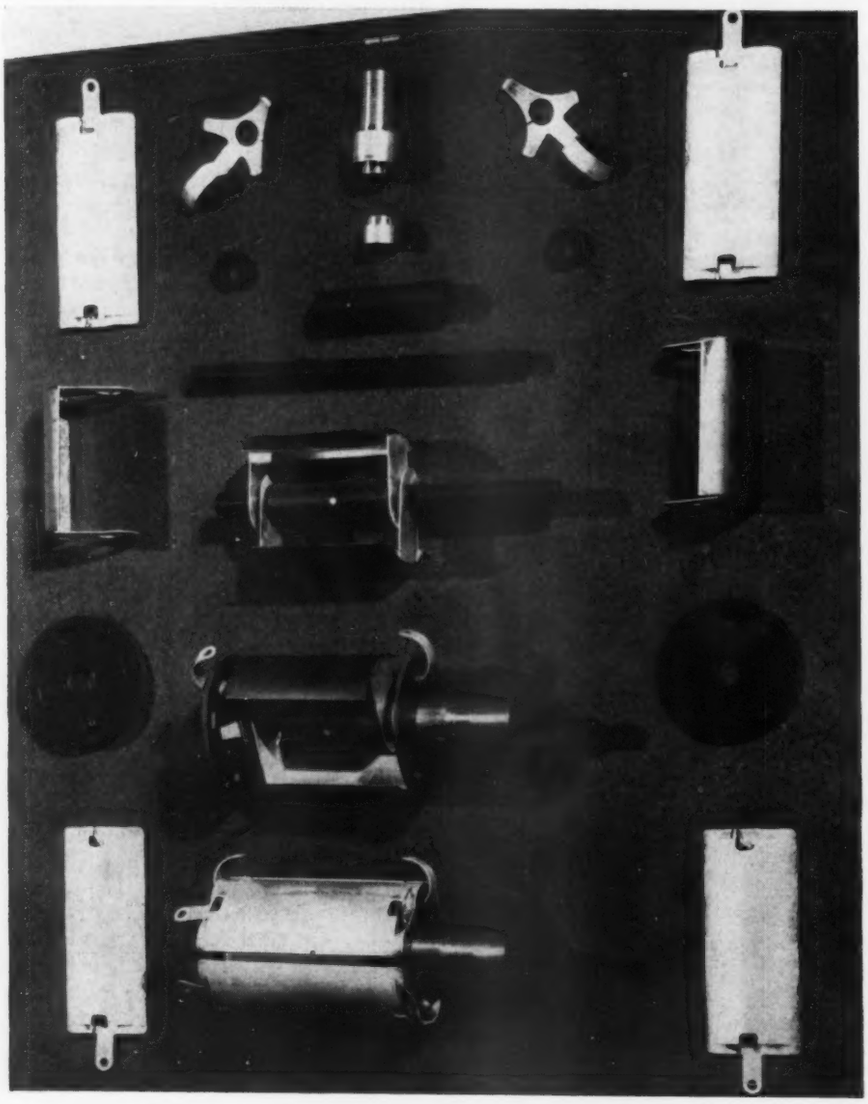
Quadrature Phased

Unique phasing control termed "Azimutrol" provides variable directivity cabinet, operate thru TV spectrum without switching. Aside from obtaining

THE decided advantages obtained by the use of mechanically rotated television receiving arrays are well known. However, the physical limitations of such an installation often out-weigh the actual benefits realized, inasmuch as the problems of maintenance and installation are more involved than those of a fixed array. In order to resolve the problem of obtaining variable directivity without mechanical rotation, an antenna embodying quadrature phasing has been patented by John Root of Square Root Manufacturing Corp., Yonkers, N. Y.

Basically, the system consists of crossed horizontal dipoles, at right angles to one another with means of varying their electrical phasing. If two such dipoles are excited ninety degrees out of phase the distribution of the radiated field is approximately circular when measured in the plane formed by the elements of the array. Varying the phasing of the elements will produce lobes and nulls in a manner which effectively amounts to rotation of the major lobes through 180°. At a given wave-length in the high frequency spectrum this condition is easily obtained. To accomplish this over a band of frequencies without undue attenuation at either extreme and at the same time maintain the desired pattern configuration several interesting design features were incorporated. The structure of the basic dipole element is a case in point, it consists of two sections, the loop portion constituting a resonant section to the higher frequency channels while the over-all length is resonant at the lower frequencies. The loop portion was designed originally to resonate on Channel 7, and the dipole to resonate on Channel 2. It was found by combining these two conditions empirically that it was possible to obtain a substantially flat response throughout the desired range. Using a tuned folded dipole at each channel frequency as a standard of comparison, the response was found to be on the order of one decibel higher on channels 7-13 inclusive, 0 decibels on channels 4-7 and minus 1.2 decibels on Channel 2. The reason for the attenuation on Channel 2 is that the inductive reactance of the loop section is not great enough to maintain signal level at this frequency. This dipole proved to have a more directional pattern than the reference antenna, and further, it developed that a 30° physical displacement of the loop with respect to the horizontal portion of the dipole made possible a proper phasing-in of the signals from the two sections of the system. The problem of vertically polarized noise pick-up is offset by the relatively narrow pattern of the loop. Orientation of one leg of the dipole section can be utilized effectively to diminish "ghosts", and if further directivity is required, both sections can be adjusted to a V con-

Photo showing components and step-by-step construction of the Azimutrol. Two stator plates, receiver terminal connecting clips and rotor shaft parts are at top. Center shows resistance coated rotor plates and rotor assembly. Final assembly is below



TV Receiving Antenna

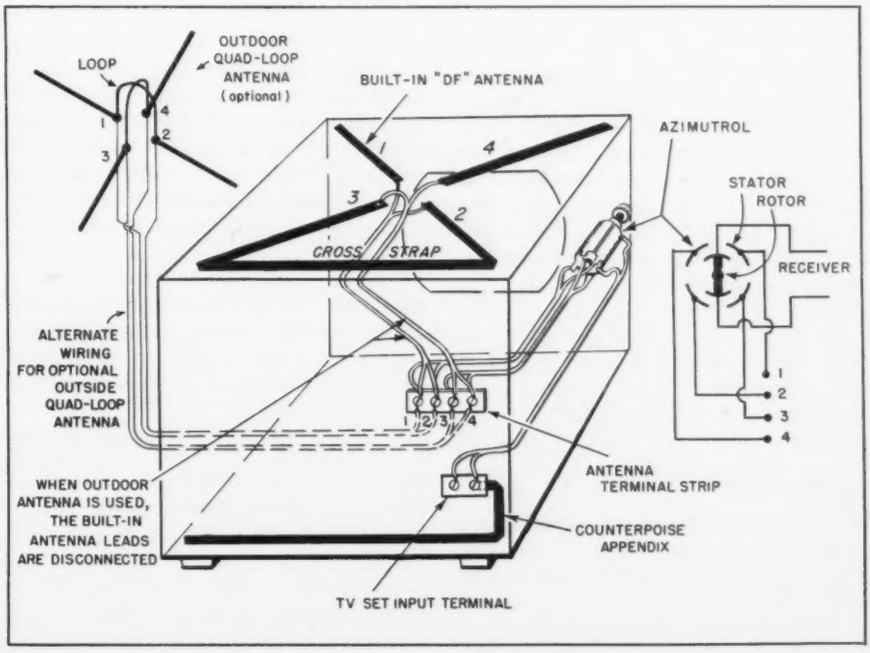
for non-rotating crossed dipole design. Both systems, outdoor and built-in maximum signal from any station, control permits minimizing ghost effects

figuration. With this adjustment it is possible to vary the pattern from that of an ordinary dipole to one having a forward lobe of roughly 30° in width, with a front to back ratio of approximately two to one.

Matching the impedance of the transmission line is no problem since the average impedance of the antenna is 180 ohms at Channel 11 while at Channel two the impedance is 240 ohms. The VSWR is negligible throughout the television spectrum.

Having evolved a satisfactory broad band dipole, the problem of combining two such elements in a quadrature-phased array was attacked. It was necessary to design a phasing device which would not introduce undue attenuation nor affect the frequency response of the system. Initial attempts to incorporate inductive and resistive phase shifters were unsuccessful. The resistive networks invariably introduced an unwanted reactive component as well as noise. Further, the losses encountered proved to be prohibitive. Experiments with an inductive phase shifter proved that the impedance matching was poor with the result that the response of the over-all system was adversely affected. Therefore a capacitive device was tried. This tended to detune the receiver input with a resultant decrease in resolution of the picture and in some cases loss of sound. For any given installation the phasing control takes a different position for each channel and consequently these detuning effects are predictable. The problem, therefore, reduced itself to obtaining a combination of resistive and inductive compensation to overcome the detuning effects. The final design of the phasing control incorporates all three components in the mechanical and material make-up of the device, all being variable.

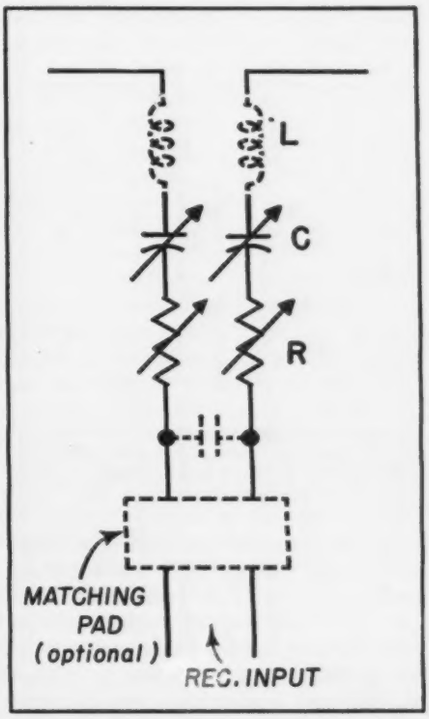
With the announcement of a built-in cabinet TV antenna by a major manufacturer, the desirability of adapting this antenna to such an installation was apparent.



(Above) Diagram showing connections of control with outdoor and built-in cabinet antennas

(Below) Equivalent electrical diagram for one dipole. C and R comprise a rotor plate and in effect are ganged. L is distributed inductance. Capacitor (dotted) represents input loading

A host of new problems had to be met to fulfill these requirements and a radical redesign of the pick-up elements was accomplished. However, the basic advantage of being able to vary the directivity of the antenna as opposed to orienting the receiver cabinet physically again made the solution desirable. A different physical configuration is necessary to reconcile the space limitations imposed by the cabinet and the desirability of approaching resonant lengths. In order to accomplish this a cross strap was connected between the ends of the two dipole sections bringing about inductive loading to accomplish resonance at the lower frequencies. A counterpoise appendix was added to act as a further load to the output of the phasing control. At the low frequencies the pick-up from this appendix is either additive or subtractive to the signal depending upon the setting of the phasing control.



Measuring Phase Angles

A discussion of problems and limitations for three phase determining methods dicating meters constructed find extensive application in development of

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DURING the past few years there has been an increasing need for methods and means of rapidly and precisely determining the phase angle relationship in communication circuits. A strictly analytical approach is apt to be long, laborious and unduly complicated by the uncertainties in the values of the circuit parameters.

This paper discusses various methods of measuring phase angles indicating the problems and limitations and suggests design criteria for phase determining instruments.

Power Factor Meters

Measuring devices for phase angle determination may be grouped conveniently into three categories: electro-mechanical, oscillographic, and electronic. Because of their limitations the first two types will be touched upon only briefly. One of the best known and certainly one of the oldest forms of phase angle measuring devices is the dyanometer-type power factor meter. This instrument is similar

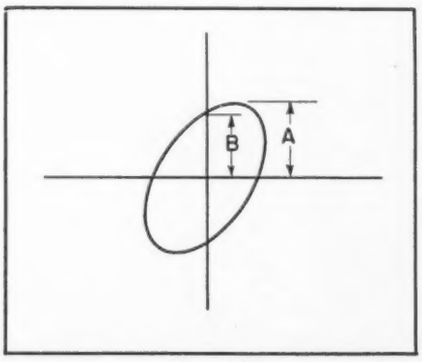


Fig. 1: Lissajous figure of voltages with identical frequency. Sin θ (phase angle) = B/A

in construction to an electrodynamic wattmeter except that the rotating system consists of two coils. One coil is connected in series with a resistor and the other in series with an inductance to create a phase quadrature condition. As in the wattmeter, the torque is a function of the cosine of the phase angle and therefore indicates cos θ or power factor which may be calibrated as phase angle degrees. A dyamometer instrument similar to the synchroscope gives equally satisfactory results.

These instruments are not particularly voltage sensitive but because of the series inductive elements they are frequency sensitive. In power systems where the frequency is of a single value and reasonably stable, the dyamometer power factor meter designed and calibrated for the particular frequency has been found entirely satisfactory.

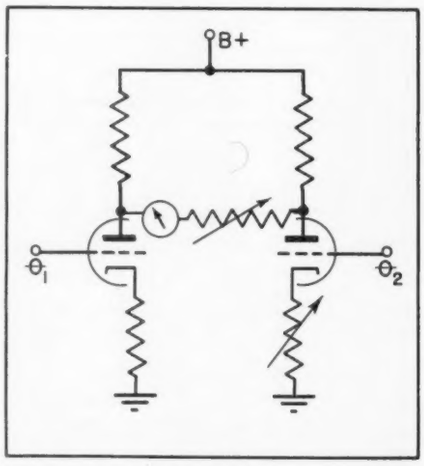


Fig. 2: Simple form of phase meter where sine wave voltages of equal amplitude are injected into the grids and the phase difference is metered as voltage between plates

Oscillographic Methods

The recording oscillograph is also used quite extensively in the power field for the determination of power factor and phase angle. It is particularly useful in situations where determination of the phase relationships in polyphase systems and equipment is desired. The most commonly used types utilize string galvanometers and their frequency response is limited by the mechanical response of the indicating element. Frequency response can be extended considerably by the use of a cathode ray tube as the indicating element.

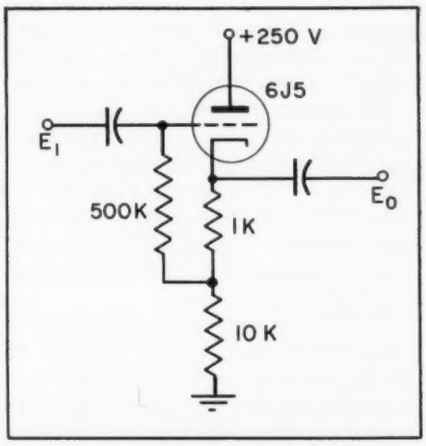


Fig. 3: Cathode follower is a desirable phase meter input circuit because its high impedance does not affect measured voltage phase

None of the recording types of oscillographs can be classed as true directly indicating instruments as the determination of the phase angle must be interpreted from a record. The cathode ray tube does however lend itself to direct indicating instrumentation and is probably one of the most widely used instruments for phase angle measurement above the 50-60 cps power line frequencies and 400-800 cps in aircraft.

Since the horizontal and vertical deflective plates of a cathode ray tube bear a quadrature relationship to each other, the application of voltages to each pair of plates will produce a Lissajous figure, which in the case of voltages of identical frequency is an ellipse. In-phase condition is represented by a straight line and quadrature phase by a circle when the wave amplitudes are equal. The phase angle θ is found by the relation sin θ = B/A as shown in Fig. 1. Phase measurements in which the voltage levels are sufficiently high to permit direct

in Communication Circuits

PART ONE OF TWO PARTS

with suggested design criteria for new instruments. Variety of direct in-amplifiers using large amounts of feedback, filters and control circuits

application to the deflecting plates may be made with a reasonable degree of accuracy by this method. When the voltage levels are low, an amplifier must be used which necessitates consideration of the phase characteristics and input impedance of the amplifier. Any finite input impedance will load a circuit being measured and affect the phase angle. This loading effect may be quite insignificant or very serious depending upon the ratio of the

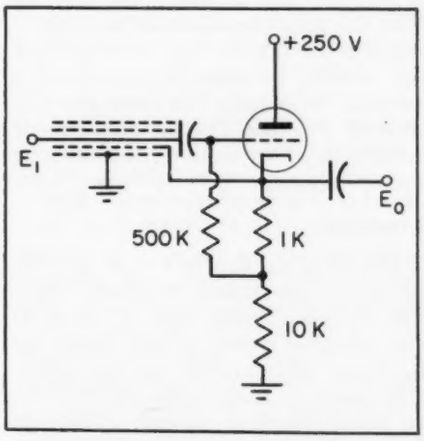


Fig. 4: Use of double shielded cable in the input reduces capacity to 2-3 μμf/ft. whereas actual cable capacity may be 20-30 μμf/ft.

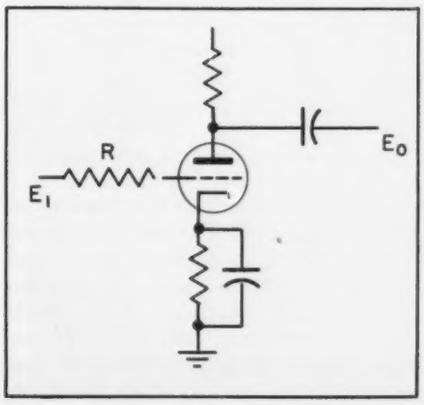
impedance at the point where measurements are being made to the input impedance of the oscilloscope amplifier. Dissimilar phase characteristics of the oscilloscope amplifiers will give misleading results. The application of a sine wave to both vertical and horizontal amplifiers should produce a straight line on the tube screen with any gain setting or signal frequency. An elliptical screen pattern indicates a phase dissimilarity between the amplifiers and must be corrected within the amplifier or with external phase shifting networks before any accurate phase measurements can be expected.

There are many variations on the use of an oscilloscope for phase measurement. For example, a PPI (plan position indicator) presentation similar to radar practice is often employed. One wave is passed through a quadrature voltage generator and presented on the screen as a circle. The second wave is applied to the intensity grid as a pulse and produces a brighter or fainter spot on the circle depending upon the polarity of the pulse. The spot position in polar coordinates corresponds to the phase angle between the subject voltages. The pulse is sometimes applied to a radical deflecting electrode forming a sharp lope on the circle the polar coordinate position again being a function of phase angle. Another approach consists of sweeping the spot horizontally with a saw tooth wave triggered or synchronized with a sine wave. If another sine wave is applied as a pulse to the vertical plates, a sharp pip will appear on the trace, its linear position being a function of the phase angle between the two sine waves. The pulse can be applied to the intensity grid instead of the vertical plates thus creating a spot on the line whose linear position is determined by the phase angle.

Electronic Meters

Although of limited utility, a very simple form of electronic phase meter is shown in Fig. 2. Sine wave voltages of equal amplitude are injected into the grids and the phase difference between the voltages is metered as a voltage between the plates. When the grid voltages are

Fig. 5: Circuit for triode peak type clipper



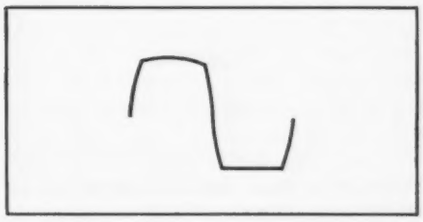


Fig. 6: Output waveform of clipper in Fig. 5

in phase the plate voltages rise and fall together and the meter reads zero. The meter reads maximum when the grid voltages are at phase opposition or 180° as in a push-pull circuit. The meter reading is not a linear function of the phase angle θ but is proportional to sine θ. This type of circuit is independent of frequency and has a fairly high input impedance but has many limitations. Applied voltages must be of the same wave form and of the same amplitude since the tubes cannot distinguish between phase and amplitude changes.

In order to have a wide service range, a phase meter should be independent of frequency over a wide band, have a very high input impedance and handle voltages ranging widely in amplitude. Furthermore it is desirable to have the meter readings a linear function of the phase angle.

Converting the sine wave signals to square waves of limited amplitude is a conventional approach to this problem. Limiting the signal amplitudes to a low level near the input stage makes the instrument relatively insensitive to amplitude changes above the limiting level. Coupling reactances should be held low and shunt reactances high to maintain insensitivity to frequency changes. With the formation of good square waves, either a summing or triggering circuit is satisfactory for measuring the phase difference between the square waves.

The input circuit to a reliable phase meter should offer a very high impedance to a measured voltage in order not to disturb the phase angle of that voltage. The cathode fol-

(*Please turn to next page*)

lower immediately presents itself as the most desirable input circuit. With the input circuit of Fig. 3, the resistance looking into the grid is approximately 4.5 megohms. The approximate input resis'ance is found by the formula

$$R_i = R_g/(1 + AR_2/R_1 - R_2)$$

where A is the stage gain. Because the input capacity is lowered by approximately the same percentage that the input resistence is raised, as shown by the formula $C_i = C_{gp} + (1 - A)\ C_{gk}$, the input capacity would be in the order of four micro-microfarads. With the circuit of Fig. 4 using a double shielded cable, the input capacity would be only 2 or 3 micro-microfarads per foot of cable length although the actual cable capacities may be 20 or 30 micro-microfarads per foot. At some value of capacity from cathode to ground the input impedance may become negative and the circuit will oscillate. A positive impedance in the form of a high resistance from grid to cathode will usually cure this trouble. Oscillations can also be prevented by employing longer or shorter cabes. Minimum plate voltage to the cathode follower should be 250 volts and the cathode resistance and grid tap should be so chosen as to allow at least 40 volts signal swing on the grid. If the cathode follower can handle 40 volt signals without drawing grid current and without cutting off the plate current and the clipping level is held at one volt, satisfactory operation will result with signal voltages which may vary between these two limits.

Square Wave Generators

A little discussion is in order at this point regarding a square wave. A perfect square wave, as shown by the Fourier series $Y = 4E/\pi$ (cos X − 1/3 cos 3X + 1/5 cos 5X — 1/7 cos 7X . . .) contains an infinite number of harmonics and would require an amplifier of infinite band width to pass it. However, a practical band width would be one that extends from 10% of the fundamental frequency of the wave to ten times the fundamental frequency. If a phase meter is to operate from 30 to 5000 cps its amplifiers and clippers as well as the metering stage should have a flat response from 3 to 50,000 cps. These are considered minimum requirements, not optimum. If the low frequency characteristics of the amplifiers are poor, the fundamental portion of the wave will experience attenuation and phase shift relative to the harmonics and the wave will have a sloping top. Conversely, when the high frequency characteristics are poor the higher order harmonics will be attenuated and shifted in phase relative to the fundamental and lower order harmonics and again the shape of the wave is impaired.

There is a general misconception that a long sequence of cascaded amplifier-clipper stages will produce a perfect square wave. The fallacy in this reasoning is that any voltage amplifier with a gain greater than one must have a plate load and thus it represents a source impedance. This impedance is shunted by the conductive load of the clipper, the tube capacity of the clipper, the input capacity of the following stage and the associated wiring capacities. As reactive shunts, these elements attenuate and shift the phase of the high order harmonics and impair the wave form. The steepness of the square wave leading edge may be slightly improved after the second amplifier-clipper stage but it is hardly enough to justify more than two stages. Where a square wave is formed by a succession of amplifier-clipper stages, a more satisfactory result is obtained by coupling the voltage amplifier to a cathode follower whose output is working into a clipper. The amplifier now works into a very high impedance and the clipper shunts a very low impedance, a much more desirable condition where wide band amplification is desired. Excellent square waves can be obtained with two such amplifier-clipper stages.

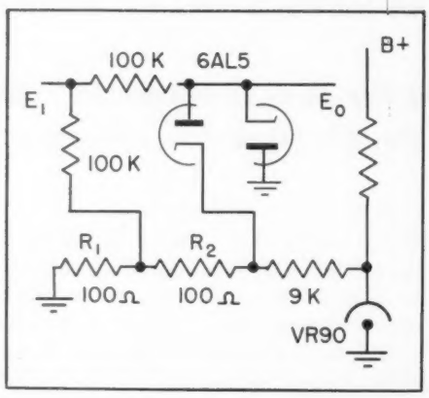


Fig. 7: Schematic of full-wave diode clipper

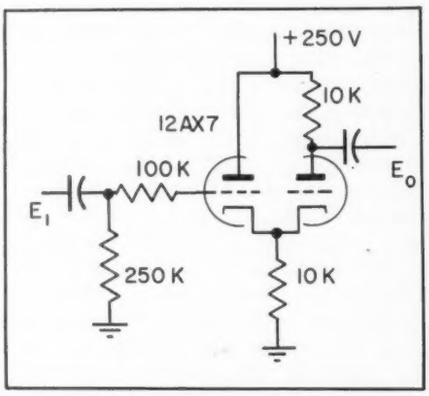


Fig. 8: Circuit of cathode coupled limiter providing square wave with good symmetry

Amplifiers

The amplifiers mentioned above are preferably of the pentode variety and are straight forward in design. The plate loads should be low for pentode tubes, usually in the order of 10,000 to 20,000 ohms. The grid bias is held low enough that the tubes are worked near their dissipation limits. The screen voltage should be well regulated by a voltage regulator or amply bypassed. For the flattest response it is best that the cathode resistors be un-by-passed.

Limiters

Clippers, or limiters, are usually of either the triode or diode type. The triode clipper, Fig. 5, cuts off the positive peak of the wave by drawing grid current and the negative peak by having its grid driven to plate current cut-off. Although resistor R may be quite large in proportion to the grid-cathode resistance of the tube, some grid current must flow to create the limiting action and this current acts as a grid leak bias to slightly raise the clipping level. This action results in a clipped wave as shown in Fig. 6. Sharp clipping is accomplished on the negative half cycle since no change in operating points results from the grid being driven beyond plate current cut-off.

A full wave diode clipper is shown in Fig. 7. The action is simply one of shunting the signals to ground when their amplitude exceeds the delay bias on the diode elements. Because of its lower plate resistance, a type 6AL5 tube makes a better clipper than the type 6H6. Since the diode current must be carried by the bleeder network, resistors R_1 and R_2 should be as small as possible and as much current carried by the net as is practical. The ratio between bleeder cur-

(*Continued on page* 60)

Dr. Lee deForest's Color Television System

Employing oscillating tri-color filters in front of picture pick-up and reproducing tubes, new method may yield inexpensive converter for time multiplex color transmissions

THE DeForest system of color television is based upon the phenomenon that if two identical transparent tri-color filter sheets each composed of equal-sized hexagonal color elements be similarly located, one directly before a non-retentive, flying spot camera tube, or image dissector tube, the other directly before an ordinary kinescope tube, and both filters be moved synchronously through a circular planar orbital path having a radius equal to one side of a hexagon and at a speed of 20 revolutions per second, then the several hexagonal color elements will appear stationary to an observer located before either of said tubes.

This optical illusion is due to the fact that every individual corresponding segment of the television raster located behind either travelling filter sheet is stroboscopically illuminated 60 times a second, and that during such brief period of illumination one of the three of any tri-color group of hexagons is in the same identical position before the illuminating tube during such brief period of illumination.

When the above conditions exist, it is obvious that the scanning beam traverses any given element of the raster while said element is projected through (at the camera tube) and/or viewed through (at the kinescope tube) the three primary colors, red, green, blue in rapid succession, and in identical "color sequence".

Now if a color transparency, or scene to be televised, be interposed between the moving color filter and the photo-electric pick-up element of the camera assembly only such colored light is permitted to pass through the filter elements to the p.e. cell as corresponds to the color of the hexagonal element which chances at that instant to be situated in the path of that light ray. Similarly if a like colored hexagon be situated at that instant before the corresponding (black, gray, or white) element on the kinescope

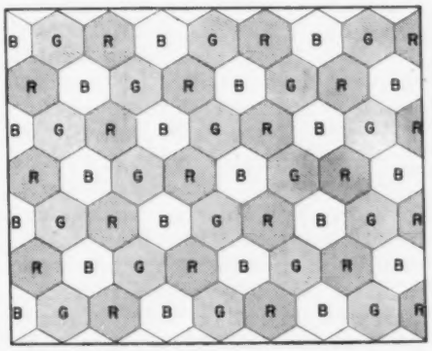


Fig. 1: Appearance of the tri-color filter which oscillates in front of the camera's pick-up and the receiver's cathode ray tube

tube that element, as viewed through the filter before the kinescope tube, will appear to the observer to be characterized by the same color as that of the corresponding original picture element of the colored image at the transmitter.

This arrangement provides that every element of the transmitted picture is "scanned" by each of the three primary colors every twentieth of a second.

This speed of color scanning is proven sufficient for all except the very swiftest moving objects, such as a base or tennis ball, and even in such unlikely cases there should not be observed a sequential red, green, and blue ball effect sometimes observed with some color TV systems because the hexagonal color elements here involved are too small, and too rapidly shifted in *orbital* paths, to permit this effect upon the eye of the observer.

In the above description it is assumed, of course, that the two color filters are in "color sync" with each other, i.e., that similar-color segments are identically located before the two similar rasters at transmitter and receiver.

Such color synchronism is not difficult to obtain at the receiver, and once obtained will so persist so long as the two driving motors are in synchronism—a condition readily assured today by any of the several proven circuit devices, operated

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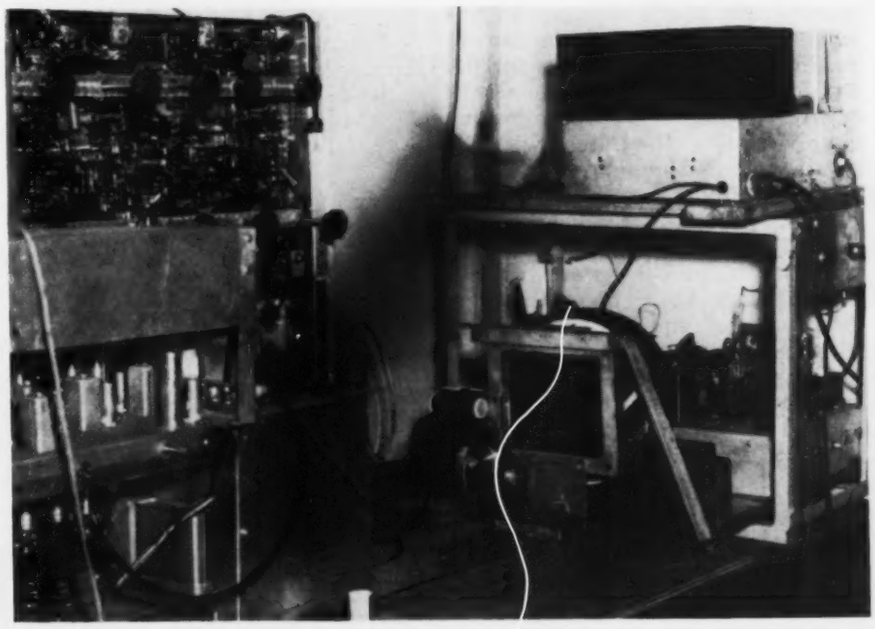
Fig. 2: Experimental transmitting equipment in Dr. deForest's laboratory. Flying spot scanner with tri-color filter element mounted in oscillating frame is at right



COLOR TV SYSTEM (Continued)

wholly by the standard R.M.A. television vertical sync. pulse. It is not required that both motors be on the same power network.

It is necessary that both the transmitter tube raster and the kinescope tube be either identical or symmetrically alike so that the same numbor of hexagonal elements be embraced by each raster. Those at the transmitter however may be very much smaller in area than those at the receiver. This is obviously feasible if the color image to be transmitted has projected upon, and through it, the colored image of the transmitter filter.

Circuits already exist for so controlling the speed (and width) of both the horizontal and the vertical sweep at the receiver, so that once set the receiver raster will remain in dimensions corresponding to those arbitrarily fixed at the transmitter.

Thus to apply these color television systems to existing monochrome TV receivers, it will be necessary only to connect to the receiver a chassis embodying the 60 cycle sync. signal amplifier (for controlling the small motor which oscillates the filter frame) plus the raster-control circuits. It is estimated that three tubes will be sufficient for these needs.

The filter frame will not greatly exceed the dimensions of the kinescope raster. It can be kept almost within the outside dimensions of the kinescope tube.

It is, therefore, perfectly feasible to apply this color system to existing kinescope tubes of 7, 10, 12, and 16 inches diameter, without enlarging the size of the existing TV receiver cabinets. Provision can be readily made for removing the filter from before the kinescope tube for black and white reception by simply sliding the filter, with its small attached motor, through a narrow window in the side of the cabinet. Or if the cabinet be sufficiently tall above the kinescope the filter frame can be arranged as to rise and fold back above the tube.

The motor required to drive the filter in its orbital motion is of small power, of 20 to 100 watts, depending on the size of the kinescope tube to be covered. A speed of 1200 rpm, to allow direct drive of the shuttle shafts, is recommended. The motor should be split-phase.

To avoid objectional parallax in viewing the receiver the dimensions of the color units, (hexagons are preferred) should be as large as is consistent with reasonably moderate excursions of the orbital shuttle. As stated above, the radius of throw of the eccentric pins carrying the moving filter frame, or shuttle, should be equal to that of one side of the hexagons. If this be chosen at ½″ the full throw of the shuttle, right to left, top to bottom, should be 1 inch, so that every element of the filter describes a circular path of one inch diameter.

Assuming that the shuttle eccentric discs (2 of these being located at the 2 lower corners of the filter frame, or if preferred three discs at 3 corners of the filter frame) are properly balanced, by appropriate counter weights, a 2-inch throw is feasible. With color hexagons having 1″ sides, and the filter located as close to the face of the kinescope tube as possible without contact therewith, parallax will be practically unnoticeable to a viewer within a solid angle of 30° from the center axis of the kinescope tube.

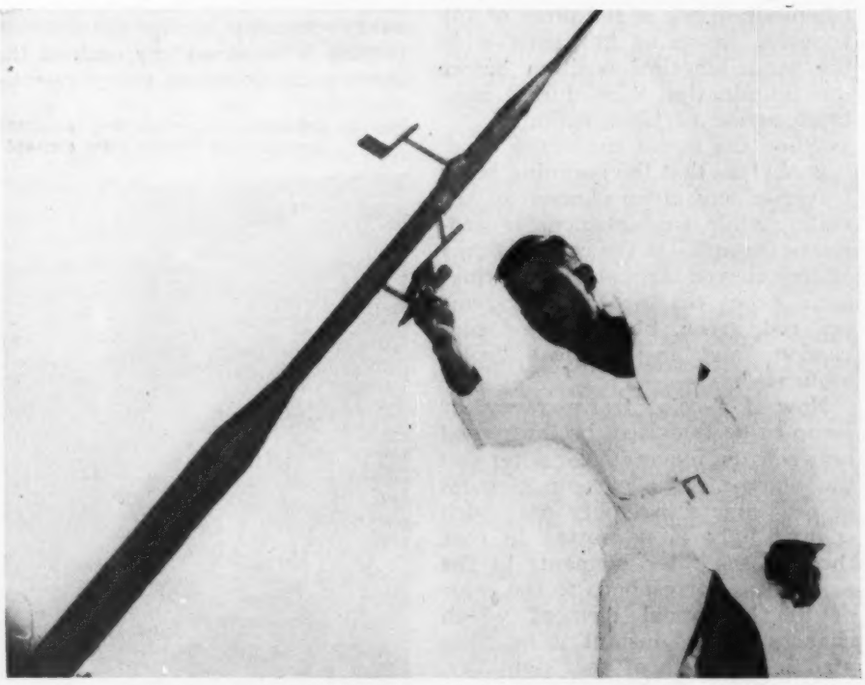
The thin transparent sheet upon which is mounted the tri-color hexagonals may be spherically curved, to have a radius slightly greater than that of the kinescope face. This will reduce still further parallax near the outer regions of the tube.

Obviously with reduced raster dimensions, and the picture thus limited to the central portions of the tube face, parallax becomes less noticeable. Also in the size of the shuttle will be correspondingly reduced. But if skillfully designed and constructed of magnesium alloy, the shuttle frame can be made exceedingly light. When correctly balanced it will be entirely free of vibration, and housed behind the cover glass, absolutely silent in all its operation. The observer can readily obtain "color sync" by a simple screw device which rotates the stator of the motor until a small tell-tale spot in the lower, or upper right hand corner appears red (or green if preferable).

To sum up: The DeForest color TV system can be readily installed in any existing TV receiver, with a minimum of required changes, and at a low cost. The attachment is exceedingly simple, dependable, quickly inserted, and readily removed to permit monochrome pictures to be viewed.

At the transmitter either a flying-spot (for colored film and slide) or an image-dissector camera (for studio or out-door pickup) may be employed. The adaptation of optical systems of existing cameras for this type of color pick-up can be readily and inexpensively achieved.

MAST FOR TELEMETERING TRANSONIC FLIGHT DATA



Temperature, speed, pitch and yaw instruments are housed in this mast, designed for Northrop Aircraft, Inc., Hawthorne, Calif. by G. M. Giannini & Co., Pasadena, Calif. It is the first mast to deliver transonic flight data by radio telemetering to ground receivers, thus eliminating lag errors found in air-pressure operated cockpit instruments

Page from an Engineer's Notebook

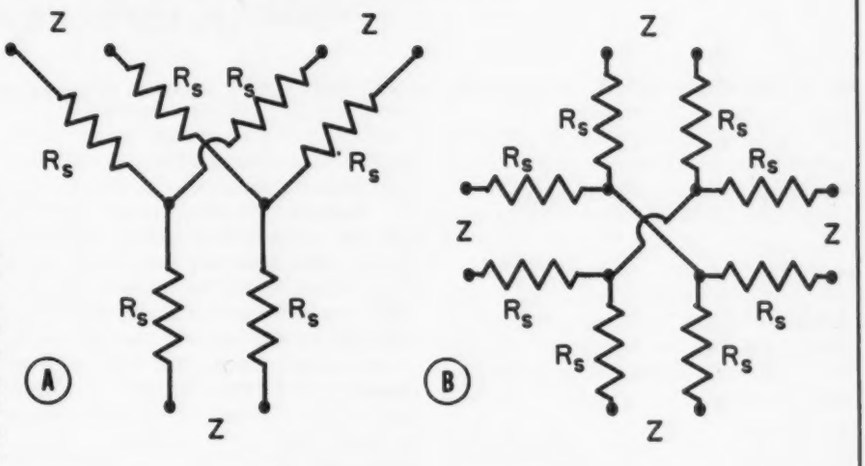
Number 4: ***Branching Networks***

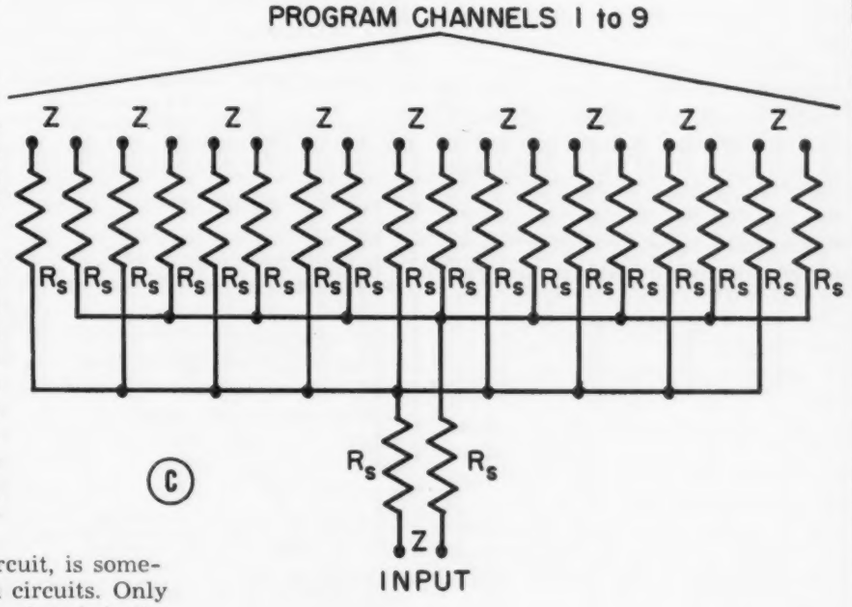
Contributed by HAROLD REED, Station WOL, Washington, D. C.

BRANCHING networks are designed to feed two or more program transmission circuits from a single wire line source or from the output of a program amplifier, while maintaining an impedance match between all channels. Since each branch must be terminated in the specified impedance in the event one of the program transmission channels is deleted while the network is in service, a resistor of the correct ohmic value must be substituted across this unused leg.

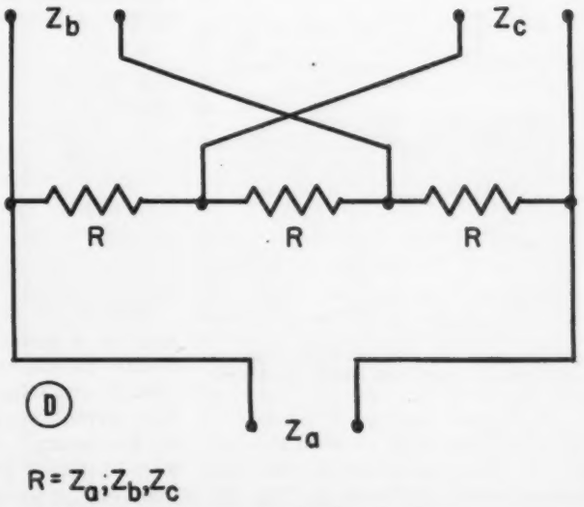
Network A having 3 branches, one in and two out, Fig. A, is often referred to as a "Y" pad. Network B has four legs, and network C is capable of feeding nine program transmission lines and matching impedances in all directions.

A table for computing the required resistance values of the individual elements of these networks is shown below, where Z is the input or output impedance, N is the number of legs (greater than 2), and R_s is the series resistors in each side of the legs. The approximate db loss is also shown. The maximum number of legs is limited only by the loss that can be tolerated in the application.





Network D, a form of a bridge circuit, is sometimes used in program transmission circuits. Only 3 resistances are used and the value of each is the same as the circuit impedance value. When an audio signal is fed into leg Z_a, this signal will appear at legs Z_b and Z_c attenuated by 6 db. It has other unusual characteristics. If two different program transmission sources were individually fed into legs Z_b and Z_c they would each appear across the output of leg Z_a. However, the signal fed into Z_b will not appear at leg Z_c. Likewise, the audio signal fed into Z_c would be isolated from leg Z_b. This network is quite critical of adjustment for complete isolation between legs Z_b and Z_c. The component parts of this network and the circuit impedances must be chosen so that a perfect balance is achieved.



$R = Z_a, Z_b, Z_c$

N	3	4	5	6	7	8	9	10
R_s/z	.166	.25	.3	.333	.357	.375	.388	.400
db loss	6.3	9.5	12.	14.	15.6	16.9	18.1	19.1

Vestigial Sideband

New unit for television transmitters employs purely signals; is smaller in size and simpler electrically

By E. BRADBURD, R. S. ALTER, and J. RACKER, Federal Telecommunication Labs., Inc., Nutley, N. J.

PART TWO OF TWO PARTS

THE theoretical results thus obtained must now be translated into a practical commercial design. The values of inductances and capacitances are such that they can be obtained only with transmission line elements. The transmission lines must be capable of handling large currents, voltages, and power. The inner diameter of the line must be sufficiently large to exceed the corona breakdown voltage in the series condensers which are built in a re-entrant manner into the inner line. The outer diameter should be such that the characteristic impedance of the line is approximately equal to 51.5 ohms. 51.5 ohm lines are used to minimize discontinuities between filter sections. Since a standard 1⅝" 51.5 ohm coaxial line is used for both the input and output of the filter, and the filter elements themselves require approximately a 4" outer diameter due to the considerations mentioned above, a tapered constant impedance line (51.5 ohms) is used to match the filter physically to its input and output connections.

The elements used in the series arms are condensers as indicated in Fig. 7. The construction of one such condenser is shown in Fig. 10.

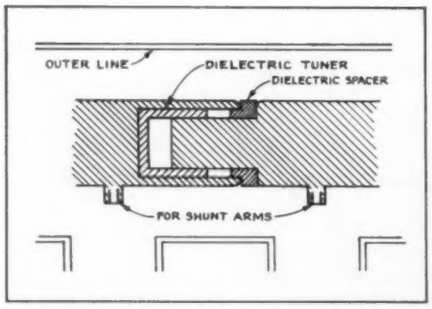


Fig. 10: Cross-section view showing construction of typical inner line series condenser

By sliding the dielectric cylinder into the air gap of the condenser, the capacity of the circuit element can be varied. The dielectric used, Teflon, was selected because it does not carbonize and hence any temporary overvoltage will not result in permanent damage to the filter.

Actually, since the series arm consists of a finite length of transmission line, there is an inductance in series with this condenser (since these lines have very low resistance all lines are assumed to be lossless). This inductance, L_{1s}, can be partially compensated over a restricted frequency band by making the actual condenser, C_p, of such a value that:

$$C_p = \frac{C_{1k}/m}{(2\pi f)^2 L_{1s} C_{1k} + 1}$$

where f is the visual carrier frequency. In this way the impedance of the series arm is effectively equal to the required $1/(j\omega C_{1k}/m)$.

The shunt arm must be equivalent to a series LC circuit, with L equal to L_{2k}/m and C equal to $(4m/1-m^2)C_{1k}$. If the impedance of this circuit is plotted as a function of frequency, the curve shown in Fig. 11 (solid line) is obtained. The problem is to obtain an equivalent impedance curve with a transmission line.

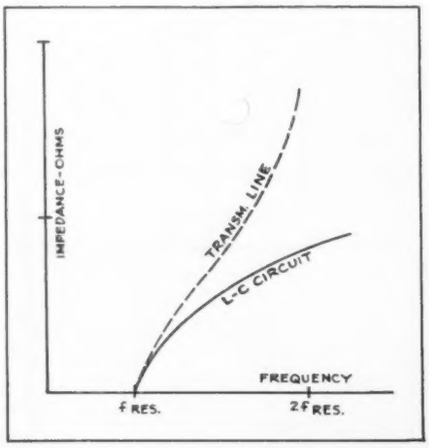


Fig. 11a: Diagram showing the impedance variation curves of series resonant circuits

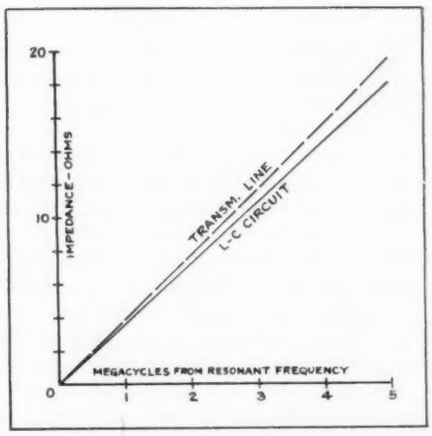


Fig. 11b: Impedance variation of series resonant circuits near resonant frequency

The impedance of a short circuited line is equal to:

$$Z = jZ_o \tan (2\pi/\lambda)l$$

where Z_o is the characteristic impedance of the line; l is the length of line; λ is the wavelength of applied signal (both l and λ in same units).

The value of Z_o used in this equation is calculated from:

$$Z_o = 1/n\pi^2 f_r C \ldots\ldots (1)$$

where n is the length of the transmission line in half wavelengths; f_r is the resonant frequency; C is the series capacitance.

This makes the slopes of the impedance versus frequency curves of the L-C and transmission line circuits equal at the resonant frequency. The series resonant arms will have a value of Z_o as close to the desired value as possible, using commercial tubing sizes.

The impedance of this line as a function of frequency is shown by the dotted line in Fig. 11. Comparing the solid and dotted lines of this figure, it is seen that the impedance variation of the transmission line is considerably different from that of the lumped LC circuit.

To obtain the desired impedance characteristic in a limited frequency band, a dual impedance line can

Filter Design

reactive network in attenuation of undesired and mechanically than many existing designs

be employed. The line, shown in Fig. 12, consists of two segments, one segment with one characteristic impedance, Z_{o1}, and the other with a higher characteristic impedance Z_{o2}. This is done physically by sliding a metallic sleeve over the inner conductor — thereby changing the outer-to-inner diameter ratio and hence the characteristic impedance for a portion of the line.

The impedance looking into this dual impedance line, short circuited at the far end (Z_{o1}) is:

$$Z = jZ_{o2}\frac{jZ_{o1}\tan\frac{2\pi}{\lambda}\ell_1 + jZ_{o2}\tan\frac{2\pi}{\lambda}\ell_2}{Z_{o2} - Z_{o1}\tan\frac{2\pi}{\lambda}\ell_1}$$

where l_1 is the length of line with Z_{o1}, l_2 is the length of line with Z_{o2}.

By proper selection of Z_{o1} and Z_{o2}, and of l_1 and l_2, an impedance versus frequency characteristic can be attained which closely matches the characteristic of the theoretical filter elements in a limited frequency band.

A trial-and-error calculation procedure is used to determine the lengths l_1 and l_2, and the impedances Z_{o1} and Z_{o2}, of this line. First the characteristic impedance of a standard type coaxial line, whose impedance-frequency slope is equal to the impedance-frequency slope of the required circuit parameters at the resonant frequency, is calculated. The characteristic impedances selected for the dual impedance line should then be slightly above and below this value. For example, in the high band, a 99 ohm line provided the required slope at the resonant frequency. The two segments were calculated to be 103 and 95 ohm characteristic impedances respectively. This choice is dictated to a large degree by the tubing from which the lines are sizes of commercially available built.

The shunt arms are attached to the series arms by means of a tapped stud which is silver soldered to the series arms. Since the shunt arms are shorted at the far end and represent a series resonant circuit there is a high current point on the shunt arm where it joins the series arm. Because these shunt arms are close together considerable inductive coupling between adjacent shunt arms was noted. This coupling was made negligible by placing thin sheets of copper on textolite spacers located between the shunt arms. In addition, these spacers were used to assure concentricity of the inner line. The copper sheets are grounded to the outer conductor along their entire periphery and are extended to within 1/8 in. of the inner conductor,

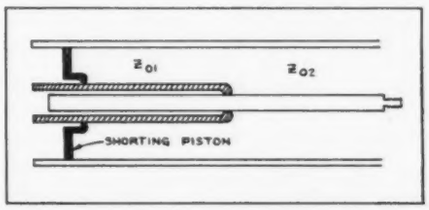


Fig. 12: Cross-section view of a shunt arm

thus effectively shielding the various portions of the filter from each other.

The equipment necessary to tune, adjust, and determine the insertion loss of this filter consists of a tone modulated signal generator operating over the full band for which the filter is being used; a 6 db attenuator (pad) for isolation; a crystal detector; and an audio amplifier. The signal generator is coupled to the filter through a pad, and the filter output is detected and applied to the audio amplifier. The following seven steps are required to adjust the filter to any channel:

1. The terminating shunt arms are tuned first — one at a time. The sliding sections of each line are adjusted until length l_1, calculated previously through the use of equation 1, are obtained. The signal generator is set to the resonant frequency of the end shunt arms. This frequency is found through the use of either of the following expressions:

$$f_r = \frac{1}{2\pi}\sqrt{\frac{1}{\frac{L_{2k}}{m}\left(\frac{4m}{1-m^2}\right)C_{2k}}}$$

$$f_r = f_c\sqrt{1-m^2}$$

2. The shorting bar on one of the end shunt arms is moved until a minimum reading is obtained in the audio amplifier. The shorting bar is then clamped at this position.

3. The sliding section of the shunt arm just tuned is then repositioned so that the shunt arm no longer resonates at the same frequency. The shorting bar of the other end shunt arm is then tuned to resonance by obtaining a minimum output reading.

4. The sliding section of the first end shunt arm is restored to its original position and the output versus frequency of the filter is checked in the region of resonance. The first sliding section is adjusted until there is only one minimum reading in this band.

5. The other two shunt arms are tuned in the same manner using the resonant frequency of these arms.

6. The series arms are adjusted

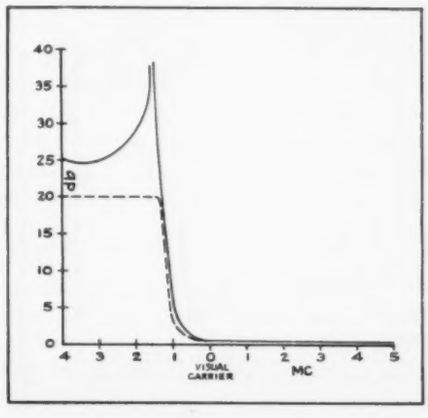


Fig. 13: Curves showing performance of filter

by tuning for maximum output with the visual carrier frequency applied to the filter.

7. Input and output connections are then reversed. Since the filter is symmetrical, the same frequency characteristics should be obtained with this set up. (If it is not, then the tuning procedure should be repeated. If still not rectified, then the design should be checked.) The

(Continued on page 60)

WASHINGTON
News Letter

Latest Radio and Communications News Developments Summarized by Tele-Tech's Washington Bureau

FCC TO DECIDE COLOR TV BEFORE OTHER VIDEO PROBLEMS—The FCC's history-making inquiry into color television, which has attracted not only nationwide but also global interest, is going onto a finish in hearings and comparative tests and demonstrations of the respective systems and now is likely to run through December. Previously, the FCC had hoped to clear up the color video phases after the comparative color television demonstrations in mid-November. But because of the public interest and importance of an effort to reach a decision as speedily as possible, the Commission determined to carry on the color video hearings until they were completed in their entirety. After the all-important comparative demonstrations of the CBS, RCA-NBC color and Du Mont monochrome video systems in mid-November and during the last week in November in San Francisco of the Color Television Inc. method, the FCC hearings will be centered on cross-examination of the score of hearing witnesses probably all during December.

COLOR TV MAY REQUIRE YEAR OF FIELD TESTS—With the Congressional pressure and the general public curiosity and desire to witness the advent of color television, the FCC had received a cauldron of seething ingredients and radio industry competitive controversies during the October hearings that will form a most difficult job for the Commission to mix and formulate a potion to bring out a solution to launch color video as a public service. Despite the leanings of two Commissioners at least, Jones and Miss Hennock, that color television could be launched almost at once, there appeared the definite outlook that color video will take *months of field testing*—six months at a minimum and more probably a year and this step of field testing may not be authorized by the FCC until early next year.

RADIO INDUSTRY DESIRES PUBLIC PROTECTION—What has not been fully comprehended both by some FCC Commissioners and top staff officials and by the Congressional leaders who are advocating immediate launching of color television is the radio manufacturing industry has a definite and deep concern of the public interest that the present more than two million black-and-white receivers (and possibly another million by the end of this year) should not be *obsoleted.* The manufacturers are not motivated by the desire to sell more monochrome sets but the industry has its reputation to be guarded to see the radio set buying public protected in its investments. The FCC should heed the ably expressed views of Radio Manufacturers Association President R. C. Cosgrove and Philco's able engineering Vice President David B. Smith on this subject —and it is felt the final outcome will be the upholding of this industry policy. This industry advice may result in the FCC establishing standards for color to permit use, in all probability, of both the adaptable and compatible systems.

BROADBAND SYSTEM MAY HIGHLIGHT TECHNICAL HEARINGS—General unanimity of views on the technical standards and problems for the UHF television allocations was understood to prevail for the radio industry's presentations in the next phases of FCC hearings after color TV. But there will be one controversy according to all indications—the television industry as represented by the Television Broadcasters Association plans to oppose the proposal of the Bell System to establish a broadband multi-channel radio-telephone system in the 470-500 megacycle range. The Bell Telephone Laboratories will present its heavy artillery in support of the broad band program, probably headed by Dr. Oliver E. Buckley, the Laboratories' President, because of the tremendous importance to the mobile radio services.

MOBILE SERVICES VARIED—While the television industry is potent in its public influence, it must be remember that mobile radio services cover a cross-section of the nation—police and fire departments, petroleum, power utilities, forestry industries and the various media of transportation—and these services likewise can wield most important support. Even though there may be such disagreements as frequency needs, the FCC hearings on television have pointed up the fact as expressed in M.I.T. Professor Maclaurin's book on the radio industry that the radio engineers have and will be the ones to lead to the right solutions in television as they have done in standard and FM broadcasting.

PROCUREMENT CONTRACTS FLOWING FROM ARMED SERVICES—Communications-electronics procurement contracts of the military services with the Air Force having the largest amount of funds will begin to flow normally now that Congress has enacted the Military Establishment Appropriations Bill of about $15 billion for the present fiscal year which commenced last July 1. While the funds measure was tied up on Capital Hill, the Air Force, Army Signal Corps and Navy have had to keep their awards of procurement to a comparative trickle of grants, but the three Armed Services have been able to advise manufacturing companies of the anticipated obligations when the bill was passed by Congress.

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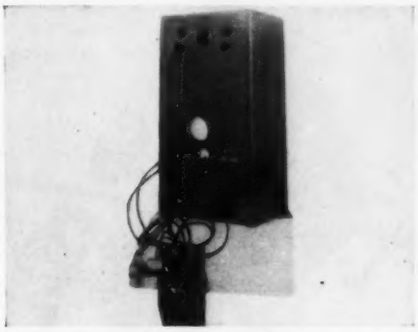
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

New Lab & Test Equipment

Wobbulator Signal Generator

Model 705 Wobbulator signal generator includes not only the components for generating a swept frequency but also a 5-in. CR tube



with associated sweep and gate circuits, traveling detector, signal amplifier, and a 100 db linear calibrated attenuator for controlling the amount of signal injected in the circuit under test. All equipment necessary to check the response curve of a circuit is provided except a marker oscillator.

The two 707B 10-cb reflex tubes used as oscillators are mounted in wide-band, tuneable shielded cavities. One, designated the fixed oscillator, is operated at a fixed frequency, and its output is amplitude modulated by applying a 100 KC/sec. square wave to the reflector. The output of the other, known as the swept oscillator, is frequency modulated by applying a tuned circuit device which rotates inside the field of the oscillator cavity.—**Canoga Corp., 14315 Besemer St., Van Nuys, Calif.**

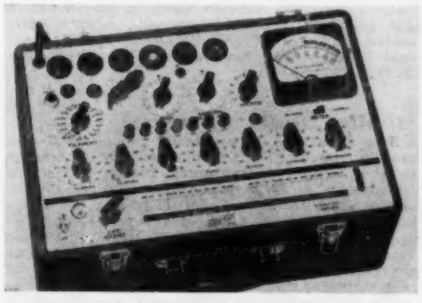
Signal Generator

Model 500K r-f signal generator is now available in kit form. It covers a range from 150 KC to over 30 MC on fundamentals and

over 100 MC on harmonics; 400 cycle internal modulation and facilities for external modulation are provided. List, $18.75.—**Electronic Measurements Corp., 423 Broome St., New York 13, N. Y.**

Tube Tester

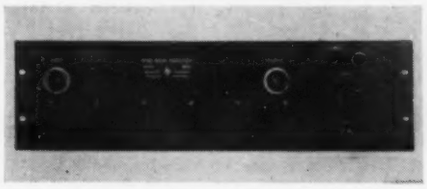
Built with dynamic mutual conductance circuits, model 600 is a newly-developed, lightweight portable tube tester. Scale read-



ings are directly in micromhos. Ranges are 0-3000-6000-15000 micromhos. The instrument is mounted in a sturdy case 7½ x 11¾ x 16¾-in.—**Hickok Electrical Instrument Co., 10606 Dupont Ave., Cleveland 8, Ohio.**

Wide Band Amplifier

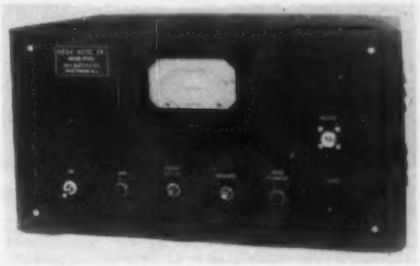
True amplification without objectionable ringing or overshoot is provided by the -hp-460A wide band amplifier, a new instrument



with a pulse rise time of only .003 μsec. and a gain of 20 db. As many as 5 instruments can be cascaded to supply additional gain. This instrument can also be used with the -hp- 410A vacuum tube voltmeter and will increase voltmeter sensitivity 10 times at frequencies up to 200 MC. Thus quick mid-scale readings of voltages as low as .01 volts is facilitated. Because the model 460A gives optimum performance through impedances of 200 ohms, a 200 ohm coaxial system of connectors and cables have been designed for use with it. These accessories include leads with fittings, panel jacks, plugs and cables, adapters to connect the instrument into a standard 50 ohm type N system; and a special adapter for use with the 410A vacuum tube voltmeter.—**Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif.**

Random Noise Generator

The Mega-Node Sr. is a calibrated random noise generator useful in determining the noise figure (db above ideal) of receivers or



amplifiers in the UHF and microwave frequency ranges. The noise figure may be read directly from the panel meter calibrated in linear db. Frequency range is from 100 to 3000 MC and output impedance is 50 ohms unbalanced. The voltage standing wave ratio at the coaxial output connector has been kept very low over the entire frequency range. Price: $895., FOB Factory.—**Kay Electric Co., Pine Brook, N. J.**

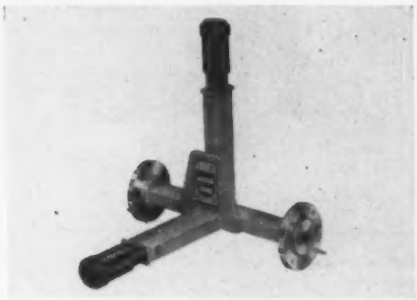
TV Power Supply

A portable, lightweight power supply capable of providing a well-regulated source of DC at loads from 200 to 300 ma has been

developed for laboratory, broadcast and communications applications. Known as the type TY-25A, the unit has an output adjustable between 260 and 290 v., with variations of less than 0.5% from minimum to maximum load. There is an AC ripple of less than 0.01% from peak-to-peak. The power requirement is 120 v., 60 cps, 300 watts.—**Radio Corporation of America, RCA Victor Div., Camden, N. J.**

Matching Transformers

E/H tuners are part of an expanded line of microwave test equipment which provides coverage of the 12,400 to 40,000 MC band.



These matching transformers consist of hybrid tee junctions in which movable choke-type shorts are placed in the shunt and series arms. By proper adjustment it is possible to reduce to a value less than 1.02 VSWRs as high as 20:1 and of arbitrary phase.—**Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.**

Field Strength Meter

Model A-460 is a lightweight, portable television field strength meter which is calibrated from 50 to 30,000 μv. An all-chan-

nel selector on the panel has a fine tuning control. Design has self-contained power supply, 115 v., 60 cps (65 watts).—**Approved Electronic Instrument Corp., 142 Liberty St., New York City**

Wide-Band Chain Amplifier

A regulated power supply on the model 202P wide-band chain amplifier insures constant gain within ±1% for line voltage variations

of ±10%. Using a traveling-wave tube circuit composed of 2 stages of 6 6AK5 tubes, this amplifier has a transmission characteristic of ±1.5 db from 100 KC to 200 MC and an impedance of 200 ohms. Because of the combination of a substantially linear phase shift and a rise time of .003 μsec., the 202P can be used in high speed pulse amplification and radar, oscillography and nuclear physics. With stabilized gain and a maximum undistorted output voltage of 4 volts, it is well adapted for use as a pre-amplifier for signal, sweep and pulse generators, vacuum tube voltmeters, TV testing, and general laboratory measurements.—**Spencer-Kennedy Laboratories, Inc., Dept. TT, 186 Massachusetts Ave., Cambridge 39, Mass.**

TV & Communications Components

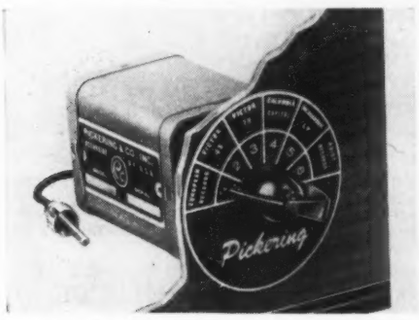
TV Lighting Mount

A counterbalanced adjustable hanger, known as the Skyhook (HP Series) has been designed for television studio lighting equip-

ment, including floods, spots and fluorescents. Model illustrated extends from 18 in. to 12 ft. and can accommodate equipment of various weights from 10 lbs. to 60 lbs. Other sizes and capacities are available on special order. The Skyhook may be suspended from pipe grids, electrical rails or structural members.—**Display Lighting Inc., 417 East 61st St., New York 21, N. Y.**

Record Compensator

Correct equalization of the different recording characteristics used by various record manufacturers is provided by the model 132E



record compensator. Because it uses linear circuit elements it has no inherent distortion. It can be connected to any amplifier which has an equalizing pre-amplifier.—**Pickering Co,. Oceanside, L. I., N. Y.**

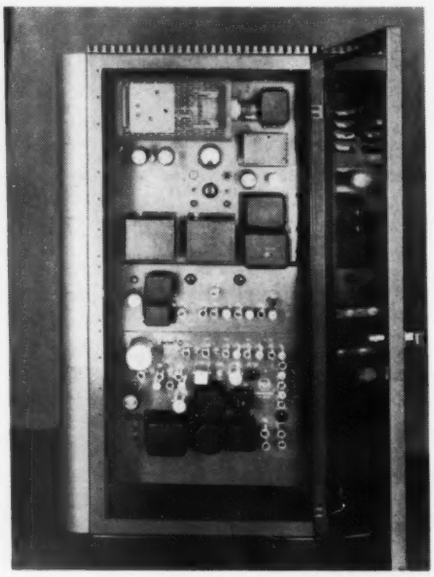
16-in. TV Mounting

The polystyrene base-mounting strap shown mounted on the 16-in. TV tube (left) provides adequate insulation and solid vibration free

mounting. Another type mount for applications where chassis design does not permit use of the base and strap unit has overlapping ends (right) which provides insulation at the meeting point. This ring incorporates a safety glass retainer rim. When the safety glass has been masked to give the desired picture shape, this ring holds and insulates the tube, holds the safety glass and eliminates masks for picture shape.—**American Phenolic Corp., 1830 South 54th Ave., Chicago 50, Ill.**

Microwave Relay System

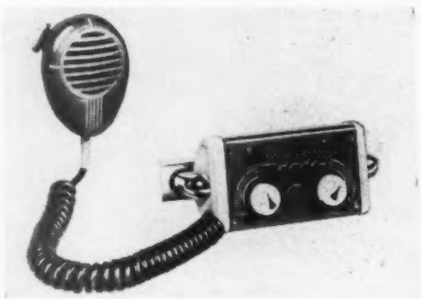
New commercial microwave relay equipment facilitating a system of high-frequency point-to-point radio communications has been de-



veloped for such diverse users as pipe lines, gas companies, electric power utilities, trucking companies, forestry services, and fire and police departments. Channeling equipment makes it possible for each radio circuit to carry 4 voice conversations simultaneously. Channeling equipment is also available to break each of those voice bands into as many as 16 signaling circuits for telemetering, signaling, or supervisory control functions. The equipment (CWTR-5A) consists of a unidirectional system comprising transmitter, receiver, and two 4 or 6-ft. parabolic antennas. A modulation channel is provided extending from 300 cps to 30 KC.—**Radio Corporation of America, RCA Victor Div., Camden, N. J.**

Mobile Control Head

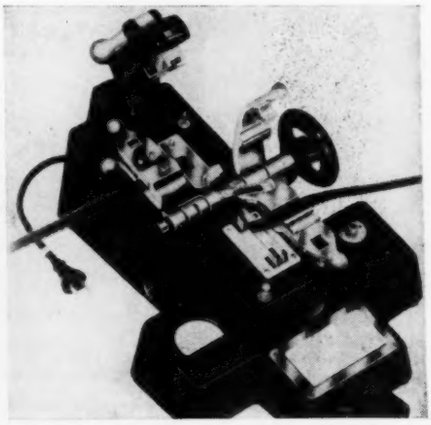
A universal control head, for use with 2-way radio mobile units, has been developed which can be mounted in any position on any type



of dashboard. Supporting plate supplied as standard equipment on the control head permits its use on all dashboards, metal or plastic. For mounting, 2⅝-in. holes are required. In the event of transfer of equipment to another car. Motorola will supply plug buttons for the holes, at no charge.—**Motorola, Inc., 4545 Augusta Blvd., Chicago 51, Ill.**

TV Film Splicer

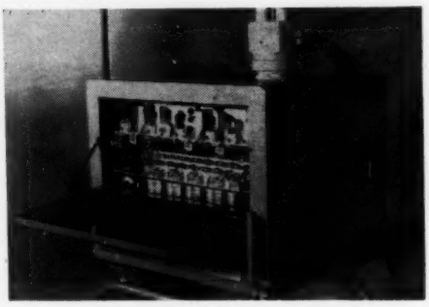
Designed to splice 35mm and 16mm motion picture film, as well as magnetic tape in these sizes, the "Presto-Splicer Professional Model"



makes splices which will hold up under the "hot developing process" which is used for high speed reproduction of TV films. The new splicer handles all types of safety film bases, including Tri-Acetate stock. It can be used for raw stock and short ends and eliminates the need for clips or staples, saves many an exposed frame and gives perfect frame line splices. List, $498 FOB Factory, New York.—**Prestoseal Manufacturing Corp., 38-01 Queens Blvd., Long Isllland City, New York**

TV Film Camera

A new video pre-amplifier is a feature of the model 4PC2B2 television film camera, a studio component with high intensity, prefo-



cused, independently adjustable edge lights which reduce edge flare and eliminate undesirable reflections. A sweep reversal switch permits use of opaque material through the slide projector. The pre-amplifier, which has 6 low-cost tubes, contains a polarity reversal switch for positive and negative film. One of the principal advantages of the pre-amplifier is the simple way in which it is aligned; only 3 peaking circuits have to be adjusted. All electrolytic capacitors are hermetically sealed and are of the "plug-in" type.—**General Electric Co., Transmitter Div., Syracuse, N. Y.**

Mobile Radio System

The Fleetfone is a highly selective 2-way mobile communication system for operation in the 30-50 Mc frequency range. Selective circuits in the receiver effectively discriminate against interference from adjacent or alternate channels. A newly-developed circuit for automatic modulation control locks the voice input level at a constant amplitude. For operation from a 6-v. battery, the Fleetfone is available with either 30-or 60-watts output. There is also a 30-watt model which operates from a 12-v. battery. Equipment also has provision for either single-frequency or two-frequency operation.—**Radio Corporation of America, RCA Victor Div., Camden, N. J.**

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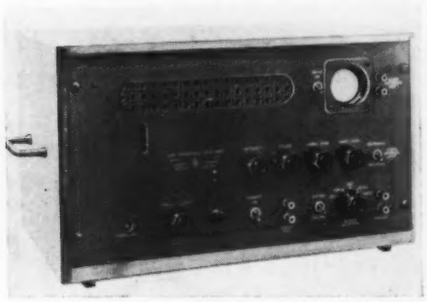
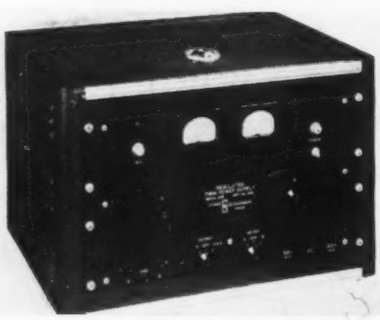


comparison are provided by the model 100D secondary frequency standard. This instrument can be conveniently standardized against US Government radio station WWV when used in conjunction with a standard oscillator and a communications receiver. Its crystal controlled oscillator and divider circuits offer new highs in stability ard operational ease. The instrument can provide sine waves at 5 frequencies and rectangular waves at 4 frequencies. Accuracy is in the order of 2 parts in 1 million.—**Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif.**

Twin Power Supply

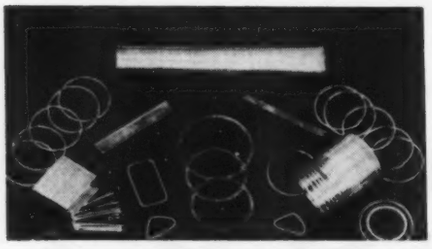
The model 1210 Twin power supply is a versatile power source for laboratories, test stations on production lines and other ap-



plications where a well-regulated source of power is desired. It produces DC power at constant output voltages, independent of variations of the power-line voltage and of the currents drawn on the load. A unique switching arrangement enables one 1210 unit to do the job of 2 separate supplies at a price which is not much higher than that of a single unit. Output voltages can be adjusted over wide ranges by 2 control knobs on the front panel. Two dc outputs are 0-500 v at 0-150 ma (300 ma combined). Two ac outputs deliver 6.3 v at 3 amp each and may be series or parallel connected.—**Furst Electronics, 12 South Jefferson St., Chicago 6, Ill.**

Preformed Solder

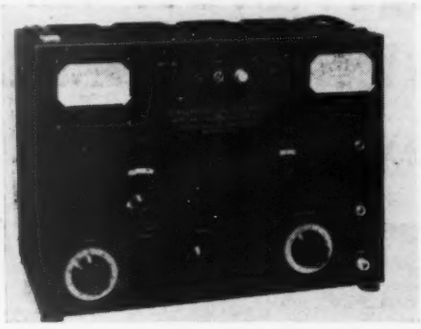
Solder preformed in rings, pellets, washers, and other unusual shapes and sizes are now available for continuous or repetitive soldering



operations. When the same amount of solder and flux is supplied for every unit soldered, waste is eliminated and rejects are reduced to a minimum.—**Kester Solder Co., 4201 Wrightwood Ave., Chicago 39, Ill.**

Signal Generator

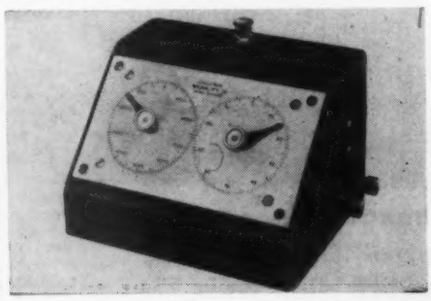
A frequency range of 20 cps to 50 MC is covered by the model 82 signal generator, an instrument which uses 2 oscillators to cover



the audio, supersonic and radio frequencies. The low frequency oscillator, continuously variable from 20 cps to 200 KC, has a metered output from 0.1 μv. to 1 v. and may be modulated with the low frequency oscillator. An improved mutual inductance type attenuator insures a higher degree of accuracy than may be obtained with the resistor attenuator or mutual inductance type attenuator of earlier design.—**Measurements Corp., Boonton, N. J.**

Coil Winding Register

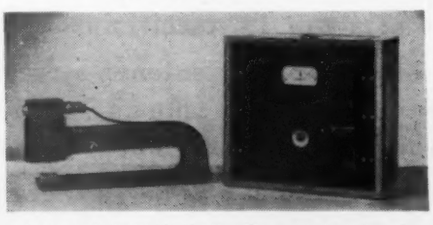
The Cyclo-Trol Register when synchronized with a coil winding machine will indicate the exact number of turns the machine makes.



It can be preset so that the machine may be stopped at any point, making possible any number of identical coils. The instrument also handles counting problems with precise control over any number of revolutions or cycles up to 10,000, with a counting rate up to 60 impulses per sec.—**Cyclotron Specialties Co., Moraga, Calif.**

Thickness Gage

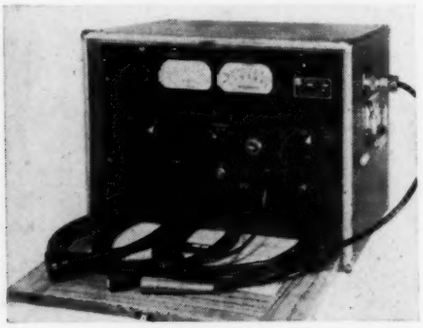
Designed for use in small production lines where initial cost must be kept to a minimum, the SM-3 beta weight or thickness



measuring gage is basically a measuring instrument made up of a radiation detector and a source of beta radiation from Strontium-90. The sheet material to be measured is interposed between the source and the detector and a part of the radiation is absorbed by the sheet material in proportion to its weight per unit area. An outstanding advantage of this type of gage is the fact that no physical contact is made with the material being measured, causing no marking of delicate or easily marred surfaces as is the case with mechanical and other contacting gages. For all practical purposes the chemical composition of the sheet being measured does not affect the calibration of the instrument.—**Tracerlab, Inc., 130 High St., Boston 10, Mass.**

Insulation Tester

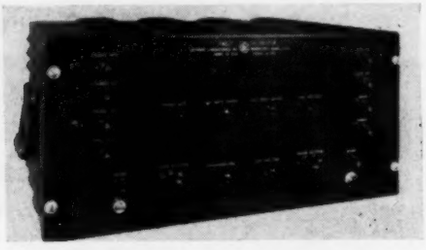
A new portable insulation tester (model 184C) provides complete facilities for taking insulation and dielectric absorption measure-



ments on cables, transformers, rotating machinery and capacitors. Equipment successfully tested with the new model includes a 50,000 Kva generator, a 5-mile cable and a complete diesel locomotove. A constant voltage transformer regulates the voltage within one half of 1%, providing constant and reliable readings under all conditions. Resistances ranging from 0.1 to 50,000 megohms may be read directly on a megohmmeter scale at open circuit voltages of 0.5, 1, 5, and 10 kv, or may be simply calculated in ranges from 0.3 to 20,000 megohms from readings of a voltmeter and microammeter connected to read resistance at any desired test voltage operating from zero v. to 10 kv.—**Radio Frequency Laboratories, Inc., Boonton, N. J.**

Sweep Calibrator

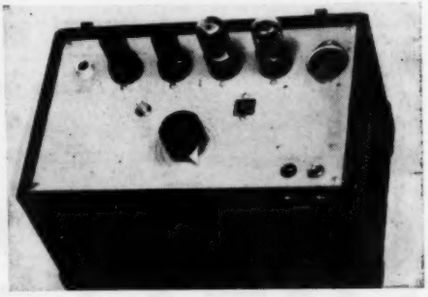
A new sweep calibrator, model GL-22A, has been developed to provide markers for accurate time calibration of synchronoscopic



sweeps. Markers at intervals of 0.1 1.0, 10.0 100.0 μsec. are provided and are suitable for deflection indicating or beam blanking presentation. A self-contained trigger generator with positive or negative output can be used to drive the calibrator and associated equipment or it may be triggered externally up to approximately 100 KC.—**Browning Laboratories, Inc., 748 Main Street, Winchester, Mass.**

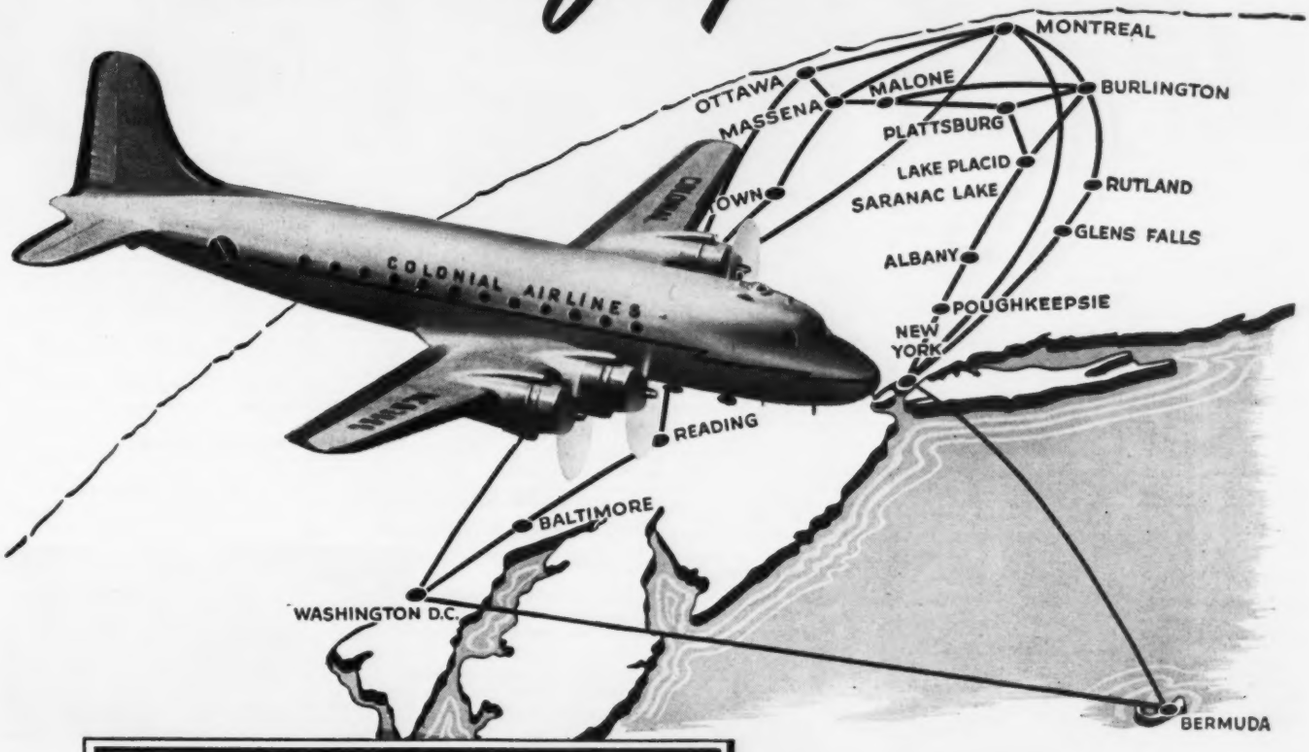
Calibrated Pre-Amplifier

Model PR calibrated pre-amplifier is an all-purpose self-contained laboratory instrument, equally suitable for portable applications. It



provides a flat response from 40 cps to 40 KC, a dynamic range in excess of 60 db, and a calibrated gain control in 5 db steps from 0 to 50 db gives a calibrated amplification into a low output impedance.—**Sound Apparatus Co., Stirling, N. J.**

SYLVANIA *Quality* LIKE COLONIAL *Safety* IS NO ACCIDENT!



COLONIAL AIRLINES is now in its 20th year with a record of over 250,000,000 passenger miles without a single passenger or crew fatality—a result of the finest personnel and equipment.

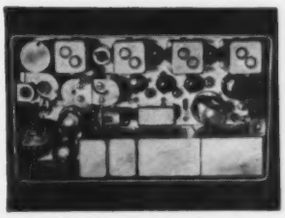
Colonial uses Sylvania Tubes in its communication system.

There's not much that can be added to those two statements. On the one hand you have a wonderful safety record by one of America's outstanding airlines. On the other you have this airline's entire communication system—a paramount factor in air safety—using Sylvania high quality tubes . . . from the new miniatures to the famous Lock-Ins.

Yes, like the *safety* of Colonial Airlines, Sylvania *quality* is no accident. We, too, insist on the best equipment—to make the finest small parts that go into Sylvania tubes. We, too, select our personnel with great care—for workmanship that is unsurpassed.

If you wish full information on our complete tube lines, write *Sylvania Electric Products Inc., Department R-1211, Emporium, Pa.*

Colonial's pilot and nagivator are in constant communication with landing field over extensive radio equipment.



Sylvania miniature tubes play prominent part in Glide Path Receiver that assists pilot in safe landing by instruments alone.

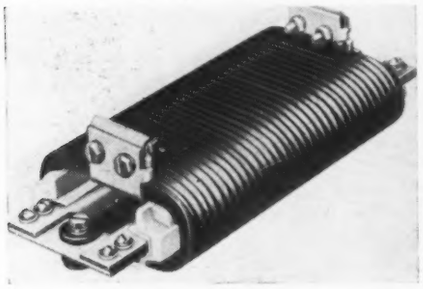
SYLVANIA ELECTRIC

RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES, SIGN TUBING; LIGHT BULBS, PHOTOLAMPS

New Parts for Design Engineers

Resistors

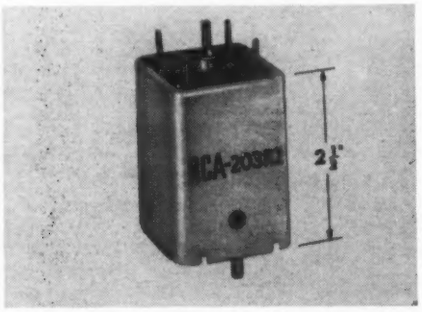
Bulletin 35 Edgeohm high current resistors are now being manufactured in 4 shorter lengths: 6, 9¼, 12½ and 15¾-in. as well as



the 19-in. length previously produced. The 4 new sizes extend the minimum resistance value per unit from 0.35 to 0.05 ohm. Continuous current capacities range from 21 to 79 amps. for all sizes. Maximum continuous duty ratings are approximately 2200 watts for 19-in. units to 320 watts for 6-in. resistors. Multiple units up to 4 in number can be supplied mounted in a single open frame.—**Ward Leonard Electric Co., Mount Vernon, N. Y.**

Frequency-Stabilizing Coil

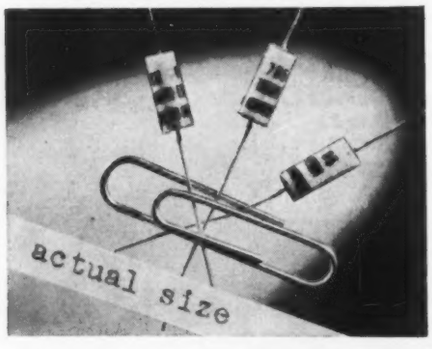
RCA-203R2 consists of a horizontal-blocking oscillator coil and a shock-excited frequency-stabilizing coil which has been de-



signed for use in television receivers employing a 6SN7-GT as a combination horizontal blocking-oscillator and synchonizing-control tube. The 203R2 is similar to the RCA-203R1 except for the addition of a synchronizing stabilizing coil which greatly improves the stability of the horizontal oscillator.—**Radio Corporation of America, Tube Dept., Harrison, N. J.**

Germanium Crystal Diode

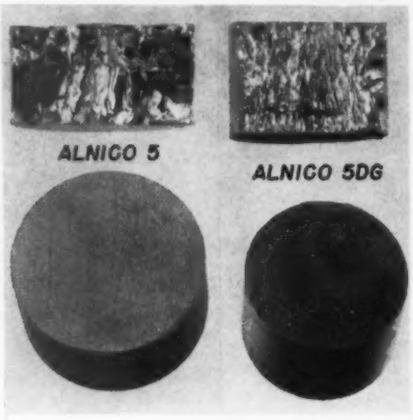
Excellent high frequency characteristics and small size (.290-in. long and .160-in. diameter) and features of germanium diode types CK705,



706, 707, and 708. They have a high ambient temperature rating of 100° C. and resistance to change in humid atmospheres. The higher temperature rating is obtained by using only glass and metal in the basic assembly, thus eliminating the necessity of a wax filler. In addition to total immersion these units have withstood more than 72 hours exposure to 95% humidity at temperatures 25° C to 70° C. —**Raytheon Manufacturing Co., Special Tube Section, 55 Chapel St., Newton, Mass.**

Permanent Magnet Material

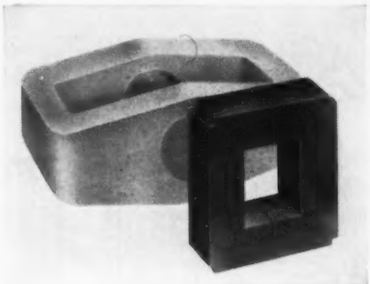
G-E Alnico 5 DG, a modification of Alnico 5, is a newly-developed permanent magnet material in which the crystal structure of



the magnet is aligned in the direction of magnetization. The letters "DG" refer to directional gain. A change in the manufacturing process has made this new structure possible. As a result, manufacturers who use permanent magnets may now use smaller magnets to do the same job that larger magnets did before. It is claimed that Alnico 5DG will provide manufacturers of radio speakers, magnetic separators, motors, instruments, and other industrial products with the highest external and residual induction of any permanent magnet material known today.—**General Electric Co., Pittsfield, Mass.**

Transformer Cores

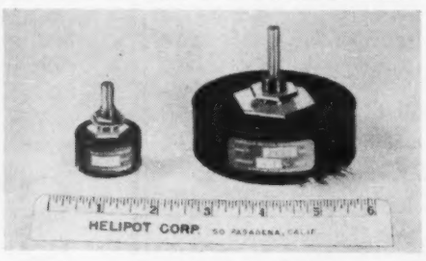
Made of newly-developed material, Stackpole Ceremag fluback transformer cores for television offer permeability on the order of



10 to 1 by comparison with previous Stackpole types of similar applications. In addition, the new cores are much smaller, have higher resistance, and operate cooler due to lack of eddy current losses.—**Stackpole Carbon Co., Electronic Components Div., St. Marys, Pa.**

Potentiometers

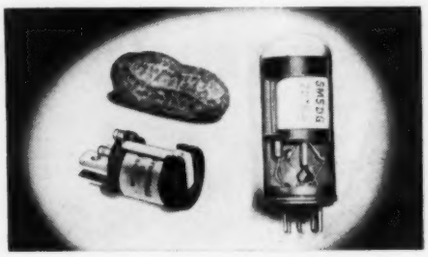
A entirely new line of precision linear potentiometers, known as model "F" and "G", have been developed after 2 years of labora-



tory and experimental tests and research. The new instruments are single turn potentiometers with continuous rotation. Model G (left) is particularly adapted to transmitting and aircraft applications. Model F (right) is especially designed for various types of computor systems. Bulletin 105 with complete description is available from the manufacturer.—**Helipot Corp., South Pasadena, Calif.**

Subminiature Relay

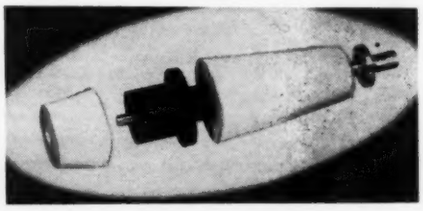
Windings as high as 8,000 ohms and adjustment for current operation to pull in as low as 3 ma, with coil consumption of 75 mw



minimum are features of the model SM subminiature relay. The standard model, wound for dc voltage actuation, draws approximately 0.5 watt, but the coil size will permit a maximum dissipation of 1.75 watts at 33° C. rise. The contacts are pure coined silver rated at 25 amps. at 115 v., 60 cycles. The extremely light weight of the moving element assures a high degree of shock and vibration resistance. Model SM is available as an open relay or hermetically sealed in a miniature glass tube envelope with a 7-prong base. Illustration compares sizes of open and sealed relays with a peanut.—**Potter & Brumfield, 549 W. Washington St., Chicago, Ill.**

Transformer Bushings

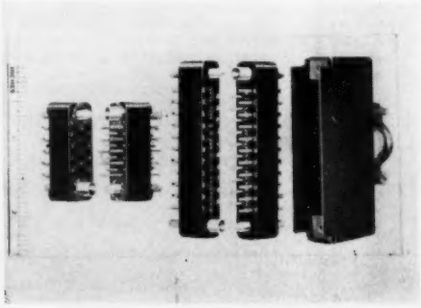
A new series of bushings have been designed especially for use on hermetically sealed transformers and capacitors. Incorporating a neoprene rubber gland between



2 pieces of steatite, these bushings can be installed easily by merely tightening a nut, thus sealing them hermetically against transformer and capacitor cases. They will resist oil and pitch, defy high heat, have extremely high dielectric strength, low power loss and high resistance to physical and thermal shock. 25 sizes and designs are available. Mounting hole requirements range from .175 in. to 1¾ in. Special bushings can be designed for unusual applications.—**Heldor Bushing & Terminal Co., Inc., 60 Park Place, Newark 2, N. J.**

Miniature Connectors

Miniature lightweight rectangular connectors are now available in 14, 21, and 34 contacts. Insulation is molded Melamine for high



arc resistance and mechanical strength. Contacts for #20 AWG maximum wire size, are gold flashed over silver plating for low contact resistance and ease of soldering. Guide pins are provided to facilitate alignment and polarization. Breakdown voltage is 5200 v. DC, 3600 v. AC.—**Wincester Electronics Co., Dept. TT, 6 East 46th St., New York 17, N. Y.**

Standardize on Dependability

AUTOMATIC ELECTRIC

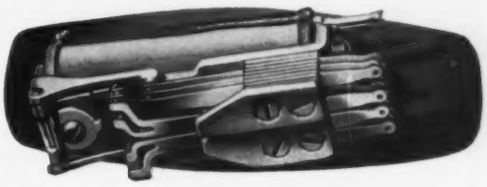
CHICAGO

RELAYS

In Automatic Electric's complete line of relays, there are over forty basic types—offering spring and coil combinations in almost infinite number. They are dependable and proved products of an organization that has made electrical remote control its business for more than fifty years.

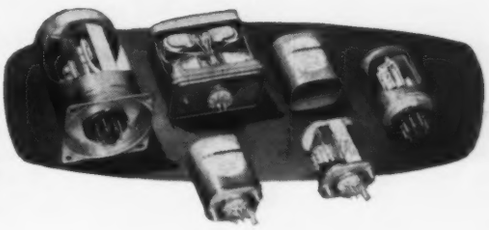
New Class "B" Relays

The newest and most outstanding member of Automatic Electric's relay family is the Class "B"—even better than the widely used, *widely copied* Class "A" Relay. Designed for ordinary relay service—opening, closing or switching circuits—and for extremely high-speed operation. Independently operating twin contacts assure perfect contact operation. Contact points are dome-shaped to maintain uniformly low contact resistance. May be arranged in one or two pileups with maximum of 16 contacts on 13 springs in each pile.



Hermetic Sealing Available To Maintain Automatic Electric Quality

All Automatic Electric Relays can be obtained in hermetically sealed housings to maintain the high quality for which these relays are famed. The "sealed-in" controlled atmosphere protects them from electrical or mechanical failure resulting from varying conditions of temperature, dust, humidity, acid, fungus or air pressure —and makes them completely tamperproof.



SWITCHES

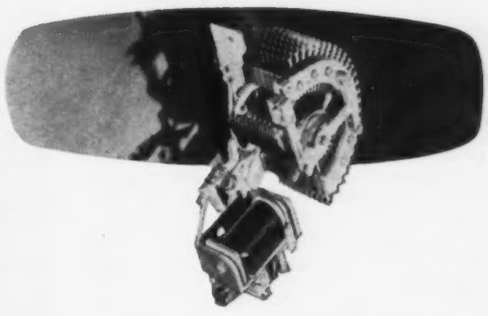
Automatic Electric Stepping Switches are designed and built to assure exceptionally long life. A complete range of Automatic Electric Switches is available for all remote control applications.

The New Type 45 Switch

Here, for example, is a rotary switch that's new and better! *Faster* . . . 70 steps a second. *Greater capacity* . . . up to 10 (or more) 25-point bank levels, with single-ended wipers available for 50-point operation. *Simpler* . . . only one field adjustment.

Compact rotary and re-set type switches are also available with 10-point bank levels and speeds of 35 steps a second for automatic or remote-control operations.

And there's the famous "Two-Motion Switch" that selects one circuit from among two hundred in just *2 seconds* or less. It's a re-set type switch adaptable to either automatic or remote control.



For help in the field of remote control, call in an Automatic Electric field engineer. Meanwhile, send for helpful literature. Address AUTOMATIC ELECTRIC SALES CORPORATION, Chicago 7, Ill. In Canada: Automatic Electric (Canada) Ltd., Toronto.

RELAYS SWITCHES

AUTOMATIC ELECTRIC

CHICAGO

TELE-TECH's NEWSCAST

Change in Radio Propagation Disturbance Notices

A new broadcast signal of the National Bureau of Standards radio station WWV has been inaugurated to improve one of the technical radio broadcast services of the Bureau's Central Radio Propagation Laboratory. This signal, a warning of unstable conditions in the ionosphere, will provide additional data on ionospheric disturbances—information of vital significance to the Armed Services and the communications industry in maintaining uninterrupted long-distance radio communications.

Heretofore two grades of propagation conditions have been recognized in the notices given at 19 and 49 minutes past each hour by station WWV, which continuously broadcasts standard radio frequencies, time announcements, and the standard musical pitch in addition to the radio propagation disturbance notices. The letter "N" (in International Morse Code) repeated several times has signified normal conditions, while the letter "W" has constituted a warning that disturbed conditions were present or expected within 12 hours. A third category, indicating unstable conditions and denoted by the letter "U", will now be used when the forecasters at the CRPL's warning center expect satisfactory reception of short wave communication or broadcast services employing high-power transmitting equipment operating on the recommended frequency, but poor results on less well equipped services. Such conditions often occur as major disturbances subside. Although point-to-point communication links are able to resume reliable operation, mobile services and short wave broadcasts continue to experience difficulty. The propagation disturbance notices, broadcast in International Morse Code, primarily refer to the North Atlantic Radio circuits.

Raytheon Establishes A Research Division

Raytheon Manufacturing Company, Waltham, Massachusetts, has established a research division under Dr. Carlo L. Calosi, director of research. Dr. Edward L. Bowles is technical con- Members of the research division staff in charge of its various sections are:

Mr. S. Rich, servo-sonic department; Dr. P. B. Carwile, ultrasonic section; Dr. W. Roth, servomechanism section; Dr. C. G. Smith, gas tube section; Dr. W. M. Gottschalk and Mr. H. G. Rudenberg, microwave and tube section; Mr. R. M. Cudmore, services section.

Radio Inventions Renamed

The corporate name of Radio Inventions, Inc. 155 Perry St., New York 14, N. Y., John V. L. Hogan's research and development laboratory which specializes in facsimile, has been changed to Hogan Laboratories, Inc. It is felt that the change in name is particularly appropriate at this time because Mr. Hogan is now devoting full time to the supervision of the engineering and development work of the laboratory and because the organization has been called upon by the government and private industry to undertake projects far afield from that implied by the former corporate name.

Elect. Reactance Fellowship

Establishment of an undergraduate fellowship in ceramic dielectrics by the Electrical Reactance Corporation of Franklinville, N. Y. has been announced by Dean John F. McMahon of the New York State College of Ceramics at Alfred University. Charles E. Krampf, president of the corporation, has appointed Door Wagner, chief engineer, C. Alan Lindquist, ceramic engineer, and William B. Tanner, personnel director, as a committee to work with Dean McMahon in directing the research.

WE Commercial Operations Assumed by Altec Lansing

The Western Electric Co. has withdrawn from commercial activities in microphones, loudspeakers, and disc recording equipment and has designated the Altec Lansing Corp., a former Western Electric subsidiary, to take over this phase of the company's operations. Specialized needs of the Bell Telephone System, combined with the growing requirements of the armed forces for development of complex electronic equipment were cited as reasons for Western Electric's decision to withdraw from the field.

Audio Society to Present Fall Lecture Series

The Fall Lecture Series of the New York Chapter, Audio Engineering Society will be held weekly starting November 10 in Steinway Hall, 113 West 57th St., New York, N. Y. For members and applicants, subscription for the complete course will be $16.00, single lectures $2.00 each. The subscription will be $24.00 for non-members, single lectures $3.00 each. Inquiries and reservations should be directed to F. Sumner Hall, Course Chairman, Audio Engineering Society, 153 West 33rd St., New York, N. Y. The lectures and dates on which they will be presented are as follows:

1 — PSYCHOACOUSTICAL ASPECTS OF THE RECORDING PROBLEM — Nov. 10
Dr. H. F. Olson, RCA Laboratories, Inc.
W. B. Snow, The Kellex Corp.

2 — THE RECORDING PROCESS — A SURVEY — Nov. 17
C. J. LeBel, Audio Instrument Co.
1947 Broadway, New York City
C. R. Sawyer, Western Electric Company, Inc.
195 Broadway, New York City

3 — DISC RECORDING — EQUIPMENT — Nov. 22
Theodore Lindenberg, Fairchild Recording Equipment Corp.
154th St. and 7th Ave., Whitestone, N. Y.

RADAR INSTALLED AT MARITIME TRAINING STATION

Features of this CR-101-A 3.2-centimeter radar, installed in a classroom of the U. S. Maritime Service Training Station at Sheepshead Bay, N. Y., are pointed out by Radiomarine radar technician Dick Scanlan. The unit was supplied by the Radiomarine Corporation of America, a service of RCA. Lt. Comdr. John J. Canavan, USMS, Lt. Milton Snitzer, USMS, radar instructors, and J. C. Affleck, advertising manager of Radiomarine look on

Norman C. Pickering, Pickering & Co., Inc.
309 Woods Ave., Oceanside, N. Y.

4 — DISC RECORDING — THEORY Dec. 1
H. E. Roys, RCA VICTOR Division
Camden, N. J.
Emory Cook, Cook Laboratories
139 Gordon Blvd., Floral Park, N. Y.

5 — DISC RECORDING — TEST PROCEDURES & PROCESSING Dec. 8
F. W. Roberts, Dictaphone Corp.
420 Lexington Ave., New York City
K. R. Smith, K. R. Smith Co., Inc.
1 Wall St., New York City

6 — MAGNETIC RECORDING — EQUIPMENT & CIRCUITS Dec. 15
P. M. Brubaker, Rangertone, Inc.
73 Winthrop St., Newark, N. J.
Myron J. Stolaroff, Ampex Electric Corp.
1650 Broadway, New York City

7 — MAGNETIC RECORDING — THEORY Dec. 22
R. E. Zenner, Armour Research Foundation
Lynn C. Holmes, Stromberg-Carlson Co.
Rochester, N. Y.

8 — MAGNETIC RECORDING — TEST PROCEDURES Dec. 29
Price Fish, Columbia Broadcasting System
S. F. Temmer, American Broadcasting Co.

9 — FILM RECORDING — EQUIPMENT Jan. 5
William H. Offenhauser, Cornell University Medical College
1300 York Ave., New York City
Dr. W. J. Albersheim, Bell Telephone Laboratories
463 West St., New York City

10 — FILM RECORDING — OPTICAL FUNDAMENTALS Jan. 12
John A. Maurer, J. A. Maurer, Inc.
37-01 31st St., Long Island City, N. Y.
L. T. Sachtleben, RCA Victor Division
Camden, N. J.

11 — FILM RECORDING — LIGHT CONTROLS & NOISE REDUCTION SYSTEMS Jan. 19
Clyde Keith, Western Electric Co.
195 Broadway, New York City
Everett Miller, RCA Victor Division
Camden, N. J.

12 — FILM RECORDING — FILM CHARACTERISTICS, DEVELOPING & PRINTING Jan. 26
Dr. Otto Sandvik, Eastman Kodak Co.
Rochester, N. Y.

13 — FILM RECORDING — TEST PROCEDURES Feb. 2
George Lewin, Signal Corps Photographic Center
E. S. Seeley, Altec Service Corporation
161 Sixth Ave., New York City

14 — MICROPHONE PLACEMENT MONITORING PHILOSOPHIES & METHODS Feb. 9
Raymond P. Griswold, RCA Victor Division
Camden, N. J.
Edward J. Content, Acoustical & Radio Engineering Consultant

15 — THE RECORDING SYSTEM — REQUIREMENTS Feb. 16
Wentworth D. Fling, Fairchild Recording Equipment Corp.
154th St. and 7th Ave., Long Island City, N. Y.
Charles M. Taris, National Broadcasting Company

16 — THE RECORDING SYSTEM — LAYOUT, RE-RECORDING, MAINTENANCE Feb. 23
Ralph A. Schlegel, WOR Recording Studios
1440 Broadway, New York City
Edward S. Sorensen, Columbia Records, Inc.
799 Seventh Ave., New York City

French Government Buys Airport Radar System

A complete airport radar system employing Ground-Controlled Approach equipment has been purchased by the French Government from the International Division of the Radio Corporation of America. The system will be installed at Orly, municipal airport for Paris, and operated by the Civil Aviation Division of the Public Works Department. Its facilities will provide for surveillance of approaching planes and for precision beam landing in adverse weather.

Annual Report of NBS

An interesting, readable summary of investigations in the physical sciences carried or at the National Bureau of Standards during the fiscal year 1948 is contained in a 272-page illustrated booklet just published by the Bureau and now available from the U. S. Government Printing Office.

Scientific activities at the Bureau during the year were conducted by 13 divisions concerned with electronics, applied mathematics, atomic and molecular physics, radio propagation, electricity and optics, metrology, heat and power, chemistry, mechanics, organic and fibrous materials, metallurgy, mineral products, and building technology. The report, 25 cents a copy, is available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

Titanium Production Increased by Du Pont

Increasing production of the newly developed metal, titanium, has been disclosed by the Du Pont Company, Wilmington 98, Del. The first small-scale commercial production of the metal was announced by the company a year ago when plant capacity was 100 pounds a day.

First ingots weighed 10 lbs. and later a method was developed to turn them out at a weight of 100 lbs. Now the plant has succeeded in making 400-lb. ingots and is prepared to make them regularly. Titanium metal is silver-white, light and strong. Its corrosion resistance is excellent. It is comparable to stainless steel in strength but weighs only a little more than half as much. It is less than twice as heavy as aluminum, but several times as strong.

TV Antenna for WXEL

Station WXEL, Cleveland, Ohio's third television station, will soon erect atop a 438-ft. tower a 6-bay high band antenna made at the General Electric plant in Syracuse, N. Y. Finishing touches on the station's $4,000,000 studio-transmitter building are now being made and station officials have informed G. E. that the first test pattern will be sent out some time in November.

Coming Events

October 31-November 2 — URSI and IRE Fall Meeting, National Academy of Sciences, 2101 Constitution Ave., N. W. and Auditorium of new State Dept. Bldg., 21st and Virginia Ave., Washington, D. C.

October 31-November 2 — 1949 Radio Fall Meeting (formerly Rochester Fall Meeting). Sponsored by Engineering Dept., RMA; Hotel Syracuse, N. Y.

November 14-18 — National Electrical Manufacturers Assoc., 23rd Annual Meeting, Haddon Hall Hotel, Atlantic City, N. J.

December 9-10 — Southwestern IRE Conference, Sponsored by Dallas-Fort Worth Section, Baker Hotel, Dallas, Tex.

January 23-27 — American Standards Assoc., Five Day Seminar on Principles and Technics of Organizing Company Standardization Work, Room 501-A, Engineering Societies Bldg., 29 West 39th St., New York City.

January 11-13—Society of Plastics Engineers, Annual Conference, Hotel Carter, Cleveland, Ohio.

SMPE 1949 Medal Awarded to Dr. Harvey Fletcher

Dr. Harvey Fletcher, whose research and development in the science of sound and sound reproduction have made him a world-renowned figure, was awarded the 1949 Progress Medal of the Society of Motion Picture Engineers at the Society's 66th semi-annual banquet, October 12th, at the Hollywood Roosevelt Hotel, Hollywood, Calif.

In the presentation of the Medal, which was made by Earl I. Sponable, president of the SMPE, Dr. Fletcher, who retired this month as director of physical research of the Bell Telephone Laboratories, was cited for his outstanding achievements in motion picture technology leading to the advance of the motion picture art and industry.

Special honors were also accorded Dr. Edward G. Kellogg, RCA Victor Division, Radio Corp. of America, now retired, who was elected an Honorary Member of the society for his contributions to motion picture sound engineering. Dr. Kellogg joins the society's hall of fame whose living members include Lee de Forest, inventor of the vacuum tube, and A. S. Howell, who developed the Bell and Howell motion picture camera.

In thirty years of teaching, research and development work, Dr. Fletcher has contributed importantly toward an understanding of the fundamental nature of speech and hearing. The results of his research appear in improved telephone service, and led to new microphones which subsequently made possible such developments as electric recording, sound motion pictures, and high fidelity loudspeakers.

H. V. Carlson Joins CEC

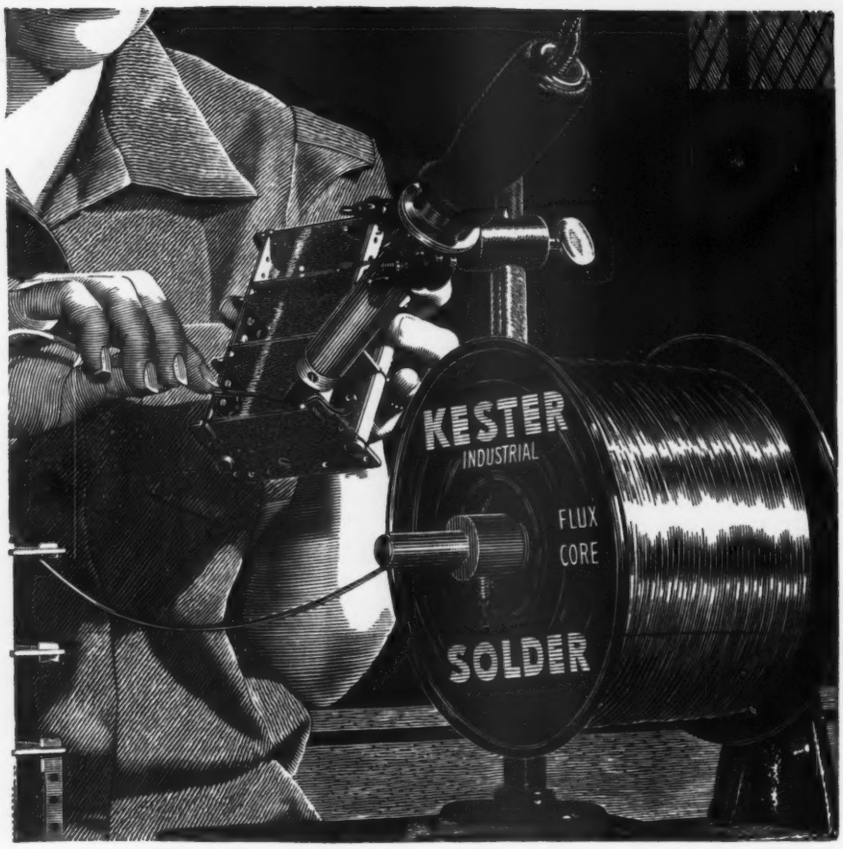
Howard V. Carlson, identified with the sale of portable radio equipment and the author of several articles on the subject, has joined the Communication Equipment and Engineering Co., Chicago 44, Illinois. This company has placed an improved portable radiotelephone on the market which has been designed specifically for railroad use, and for the other emergency radio services having a need for light weight 2-way radio facilities.

Audio Society Lectures for West Coast Section

A series of special lectures on electronic sound and acoustics will be presented as a fall educational program by the San Francisco Section of the Audio Engineering Society. The sessions will be held at Redding School, Pine and Larkin Streets in San Francisco at 8:00 P. M. on the dates shown below.

Nov. 7 — Amplifier Design, W. R. Ayres, RCA.
Nov. 21 — Attenuators & Mixers, J. P. Smith, Jr., Daven Co.
Nov. 28 — Equalizers & Wave Filters, P. W. Rounds, Bell Labs.
Dec. 5 — Amplifier & System Measurements, Ivan G. Easton, General Radio.
Dec. 12 — System Layout Philosophy and Methods, D. H. Castle, NBC, J. D. Colvin, ABC.

Individual lectures will be $2 for members and $3 for non-members. Advance reservations should be addressed to Walter T. Selsted, 363 Oakview, San Carlos, Calif.



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PERSONNEL

William B. Bergen, director of the special weapons department of the Glenn L. Martin Company's engineering division, has been named chief engineer, in complete charge of the company's engineering activities at Baltimore, Md.

Dr. E. M. Honan, formerly engineering manager of the Electrical Research Products Div. of Western Electric, has joined the Altec Companies, Hollywood, Calif.

Dr. Martin M. Freundlich, prominent for many years in vacuum tube research, has joined Airborne Instruments Laboratory, Mineola, N. Y. He heads the newly-established tube laboratory in the Applied Physics Section, directed by Rodney F. Simons

Louis L. Pacent, Jr. has been appointed manager of the industrial engineering department of the Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York 11, N. Y. He was recently connected with Radio Speakers, Inc., of Chicago, a former Emerson subsidiary.

Edward Daskam, Jr., has been named radio engineer of the General Telephone System, 80 Broad St., New York 4, N. Y. He succeeds **E. H. B. Bartelink,** who has resigned to join General Precision Laboratories, Inc., Pleasantville, N. Y.

Percy L. Spencer, manager of Raytheon Power Tube Div., Waltham, Mass., has been given the Navy's Distinguished Public Service Award for his work during the war in microwave magnetron development.

W. Oliver Summerlin has been elected vice president in charge of engineering of the Audio & Video Products Corp., 1650 Broadway, New York 19, N. Y. He was formerly chief recording engineer for Capitol Records, New York and joined Audio-Video in February, 1949 as chief engineer.

Dr. Alfred E. Rosenthal, physicist and inventor, has been appointed director of physics of Freed Radio Corp., 200 Hudson St., New York 13, N. Y., manufacturer of Freed-Eisemann Television Consoles.

Maurice Apstein has been appointed to the staff of the National Bureau of Standards, where he will do research in the ordnance mechanics laboratory of the Electronics Div.

Archibald G. Bush, former executive vice president and director of marketing and distribution of the Minnesota Mining & Manufacturing Co., St. Paul

6, Minn., has become chairman of the executive committee. **Richard P. Carlton**, former executive vice president in charge of research, engineering and manufacturing, has been named president, succeeding **W. L. McKnight** who has been elevated to the newly created post of chairman of the board.

Magnetic Tape Duplication

(*Continued from page* 30)

clutch take-up reels below. The speed is 10 in./sec. and the idealizing magnet near the lower drive wheel is excited by 600 cycle ac. The peak idealizing field in the path of the tape is about 300 oersteds and drops off slowly enough so that no 600 cps magnetization can be detected in the tapes.

Elaborations on this design to make many simultaneous duplicates will immediately suggest themselves to the reader. By means of a number of supply and take-up reels, driving wheels, and idealizing fields the device can be expanded to produce any number of duplicates. There are also other promising designs in which the master tape is wound on a drum rather than being driven between reels.

A portable machine similar to that of Fig. 3 is shown in Fig. 4. The tape speed here is about twice that of the experimental model, the ac frequency is about 2000 cps, and the field is directed transversely with respect to the tapes. The small case at left is an oscillator supplying the idealizing magnet, while the case on the right contains only the tape driving mechanism. This machine makes only one copy at a time and is intended to demonstrate the principles of the process rather than to produce duplicates economically.

While this process seems most useful for large scale production of tape recordings, its application is not limited to tape as a medium. Recordings on discs, drums, sheets, and the like can also be duplicated in this manner. It does not seem applicable to the duplication of wire magnetic recordings but it is, of course, not limited to reproducing recorded sound but may be used to duplicate pulse recordings or magnetic recordings of the types encountered in sorting machines, electronic computers, etc. Some use may be made of the process for small scale reproduction, such as: "carbon" copies of magnetically recorded letters, conferences, and miscellaneous program material, but the major use visualized is in the large scale production of prerecorded music reels.

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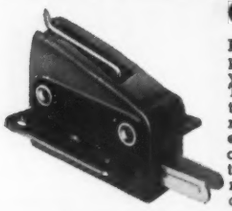
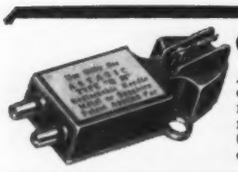


GC CERAMIC CARTRIDGE

FIRST MAJOR engineering stride in phonograph pickup cartridges employing ceramic elements since Astatic pioneered in this type unit last year. The GC is the first cartridge of its kind with replaceable needle. Takes the special new Astatic "Type G" needle—with either one or three-mil tip radius, precious metal or sapphire—which slips from its rubber chuck with a quarter turn sideways. Resistance of the ceramic element to high temperatures and humidity is not the only additional advantage of this new development. Output has been increased over that of any ceramic cartridge available. Its light weight and low minimum needle pressure make it ideal for a great variety of modern applications.



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LQD-J not equipped with needle guard or front bracket.

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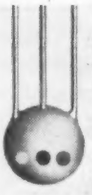

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BOOKS

Reference Data For Radio Engineers

Publication Department, Federal Telephone & Radio Corp., 67 Broad St., New York 4, N. Y. 3rd edition, 640 Pages. Price $3.75 per copy or $3.00 per copy in lots of 12 or more.

In the preparation of this third edition, the material of the previous edition has been completely revised, and new material added where experience has shown a need.

For example the material on "Frequency data" has been completely revised in accordance with the decisions made at the 1947 Atlantic City conference and a section of the characteristics of station WWV transmissions has been added. A table of the principal atomic constants has also been added and the dielectric constant and dissipation factor of approximately 130 of the more useful insulating materials have been listed for six frequency ranges. Data on components (resistors and capacitors) has been expanded, and a table of transformer-lead color codes has been included. A section on the use of operational calculus and the LaPlace transform in the solution of transient problems is presented.

The material on selective circuits has been greatly expanded, and now includes design formulas for double-, triple-, and stagger-tuned circuits. A completely new chapter on filter networks has been compiled, and includes impedance and phase-shift curves and design equations for low- and high-pass, and band-pass and band-stop networks.

Twenty-four of the more widely used impedance bridge variations and their use in measurements are discussed. Descriptions of grid-controlled gaseous rectifiers as used in high-power, high-voltage supplies are given, together with design information for all types of filter circuits for power supplies. The design of iron-core transformers and inductors is given adequate treatment with charts, tables, and design equations for power, audio-frequency, and carrier - frequency transformers.

The third edition also presents new data on the latest high frequency types of electron tubes, including traveling wave, magnetron and klystron types; information on non-sinusoidal generators, capacitive-differentiation and integration amplifiers; pulse time division multiplex modulation; radio noise and interference, and electroacoustics.

Acoustic Measurements

By Leo L. Beranek, Published (1949) by John Wiley & Sons, Inc., 440—4th Ave., N. Y. 16, N. Y. 914 Pages with over 500 illustrations. Price $7.00.

This book discusses the basic facts underlying nearly every type of acoustic measuring apparatus. Here at last it seems we have a general reference available in the field of acoustics that presents in one place in a simple but complete form, the answers to the problems of the audio engineer. While,

according to the author's statement, it is intended primarily for graduate students we believe that it is well suited as a general handbook for all workers in these fields.

The field of measurements is so broad that many of the other engineering problems arising are handled as well. Along with concise descriptions of the measuring technics that have been devised in acoustic research and audio applications, we find interesting background description, the terminology and definitions, and many bibliographical references cited. Even non-engineering technicians should find this book a handy source of information, since it covers all of the equipment and accessories in the field.

Improved Radio Systems

(*Continued from page* 33)

arating the two frequencies. The outputs are then applied inversely in the crosspointer circuit to produce the standard indications. In the new system a 10 KC subcarrier is modulated by a 30 cps reference signal. This modulation is compared with the 30 cps modulation of the carrier. The two signals after rectification are fed into a wattmeter circuit, or differential rectifier, which drives the cross-pointer indicator. This circuit is also useful for combined use with the omnirange receiver: For example, if a zero to 360° phase shifter calibrated in terms of azimuth, be inserted in one of the 30 cycle channels the receiver can be used as an omnirange receiver.

The VHF omniranges have been in use for some time and eventually all the ranges will be converted to this system. The VORs (VHF omnirange) have already been described in many papers; however, the experimental LOR (low frequency) has not been widely publicized. In operation it is very similar, and from the operator's point of view, the same. The LOR operates with a carrier frequency of 194 KC modulated with 30 cps and a sub-carrier of 210 cps at 30 cps with a deviation ratio of one. This experimental setup is installed at Nantucket and early tests with the Coastguard indicate a high order of accuracy.

In conclusion a tabulation of the radio equipment used and projected for modern aviation installations is given in a form which ties the uses of the various pieces of equipment together. Equipment in the black rectangles has either been developed, or is in the process of final construction. The remainder is still in the preliminary design stages. The scope for ingenuity and inventiveness in design is still very wide.

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MEASURING PHASE ANGLES

(*Continued from page* 40)

rent and diode current should be high. Poor regulation in this delay bias supply will cause rounded tops and bottoms to the clipped wave due to changes in clipping level during conduction periods.

An interesting cathode coupled limited is shown in Fig. 8. When the grid of tube V_1 becomes highly positive the cathode voltage increases and cuts off the plate current of tube V_2 raising the voltage at the plate of V_2 to the supply level. When V_1 grid becomes negative, V_1 plate current is cut off but V_2 plate current is increased which drops the voltage at the plate of V_2 to about 70% of the supply level. An excellent square wave of good symmetry can be obtained by such a limiter.

Triggering Circuits

There are several types of practical metering circuits and the choice of any one depends upon the result desired. The square waves can be either differentiated into sharp pulses to operate a triggering circuit or they can be used directly in a summing amplifier circuit. A satisfactory trigger circuit is the conventional Eccles-Jordan. By firing the tubes alternately with the signal pulses, the average plate current through either tube will be directly proportional to the phase angle between the two triggering pulses. Phase angle readings from 0 to 360 degrees result from this type of circuit. This circuit becomes jittery near 0 degrees since the tubes are confused as to which should fire first. If the pulses are very sharp and have an amplitude ratio of approximately two to one, this jitter can be reduced to as little as 1 degree. If a phase inverting stage is introduced into one channel of the wave forming circuits, a zero centered meter between the plates of the Eccles-Jordan tubes will provide a phase angle meter as well as a lead-lag indicator. The meter reads 180 degrees of phase angle on either side of center and the direction of reading from zero reverses if the signal input terminals are reversed. Lead-lag indicators and summing amplifier metering circuits are often incorporated in the same instrument to increase its utility.

(*Part two of this article will appear in the December issue.*)

Vestigial Sideband

(*Continued from page* 45)

filter is now permanently tuned for operation on the desired channel.

The insertion loss of the filter is determined by subtracting (in db) the detector output — when the signal is passed through the filter — from the output obtained when signal is applied directly to the detector. Fig. 13 is the measured characteristic curve of the VSB filter, described in this article, for a typical TV channel. (Also shown is the desired VSB curve.) As seen in this figure, the response is flat to within 2 db minus .75 MC to plus 4 MC of the carrier frequency, while a drop of better than 20 db is achieved between minus .75 MC and minus 1.25 MC. The attenuation of the filter exceeds 20 db for all frequencies lower than 1.25 MC below the visual carrier.

Comparing the measured curve with the theoretical mismatch val-

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ues given in Table I and Fig. 8, it is seen that the expected results were essentially obtained. The slight discrepancies between the two could be due to I^2R losses in the filter, and mismatch between sections within the filter since it is impossible to attain the exact calculated values.

These results — which meet both FCC and RMA requirements—were achieved with a unit that is considerably simpler, both mechanically and electrically, than previous designs providing the same service.

Color TV Glossary

(*Continued from page 27*)

lens through which the rays pass.

Sampling Pulse Generator

A circuit, controlled by horizontal sync pulses, which in turn produces the timed pulses needed to actuate the electronic commutator.

Sequential Systems

A system in which the colors are transmitted one after the other and which depends on eye retention and picture tube storage to combine them. Is used for line, dot, and field sequential operation in which the respective elements are produced sequentially.

Simultaneous Transmission

A system in which the primary colors are transmitted at the same instant and are superimposed one over the other at the receiver.

Subtractive Color

A system which subtracts two colors from white light and leaves the required color.

Time Multiplex

Successive transmission of pulse samples of each of several signals.

New Short 16-in. Picture Tube For TV Sets

A new 16-inch metal television picture tube, five and a half inches shorter than present kinescopes for 16-inch television sets, has been developed by the Tube Department of the Radio Corporation of America.

The new picture tube, designated the RCA-16GP4, will be supplied in very limited quantities to makers of television receivers in December. Appreciable quantities will be available early next year, company officials revealed.

The new television receiver tube has a funnel-shaped metal cone, with a glass face plate sealed to the large end and a tubular glass neck containing the electron gun fused to the smaller end.

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BROADCASTERS TO CONTINUE INTERCITY TV RELAYS

The nation's television broadcasters will be able to continue operating their own intercity television relay systems in the foreseeable future—until the Federal Communications Commission makes a specific finding that common carrier facilities are adequate in the area concerned and terminates their special licenses—under an FCC proposed decision in the long-standing "interconnection" case.

If the philosophy of the FCC proposal is carried out in a final decision, doubtless the nation's telecasters who operate their own intercity relay facilities will be able to continue them for long periods. The Commission workload is not expected to abate in the next few years, and specific findings that common carrier facilities are adequate in given areas would be slow in coming. The proposal is regarded by telecasters as infinitely better than the plan indicated previously —that telecasters would be given a specific period of time to amortize their intercity relay links.

The proceeding stems from the protest of the Television Broadcasters Association, the Allen B. DuMont Laboratories, and the Philco Corp. against a Bell System tariff provision that the telephone companies will not connect their intercity TV channels with those of anyone else if telephone company links are available.

FCC vote was 4-1, with Chairman Wayne Coy and Commissioner George Sterling not participating, and Robert F. Jones dissenting. Although FCC proposed reports are seldom upset in the final decision, a substantial time lag may ensue before the final verdict. Exceptions by the parties in the case and oral argument are necessary before the final decision—and the Commission has plenty of other problems.

Substance of the proposed decision was that the interconnection ban should not apply in the following instances: (1) where the Bell channels are to be connected to the private facilities of broadcasters, prior to the ultimate FCC termination of the broadcasters' temporary authorizations; (2) where the Bell facilities are to be used in connection with broadcasters' mobile TV pickup units; and (3) where the Bell intercity links are to be connected with networks partially constituted by direct pickup of video programs and further relay.

On the request of the Western Union Telegraph Co. that the FCC require interconnection only of common carrier's facilities, the Commission concluded that while it has the legal authority to make such a decision, it must consider such requests on a case-by-case basis. As a result, Western Union will have to make application for each point where it wishes to interconnect, and go through the usual Commission hearing.

In its proposed report, the FCC reaffirmed its earlier stand that eventually television network transmission must be carried on by common carriers for reasons of frequency economy. It stressed that broadcasters "who venture into the business of relaying television programs in these frequency bands should plan to amortize their investment at the earliest possible date."

RELAYS BY Guardian

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Low in *price*—fast in *delivery*—high in *quality*—the Guardian Series 600-U Relay meets industry's need for a small, compact, low cost relay. Yet, in performance it equals many larger more costly units. Underwriters approved.

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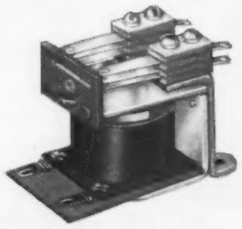
The Guardian Series 600-U Relay consists of two basic parts: (1) Coil assembly—(2) Contact assembly, interchangeable to accommodate various voltages. Use it for heat control, home laundries, business machines, etc. Write

Send b/p for specific recommendations



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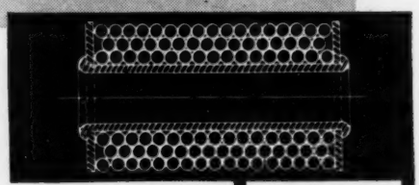

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LETTERS . . .

Silicones for Electrical Insulation

Editors, Tele-Tech:

Under "Editorial Comments" in your September issue of Tele-Tech we are very interested in the paragraph entitled "A Hot Electronic War". This article was reporting future Navy requirements for electronic equipment capable of withstanding temperatures up to 250°C.

The relatively new organo-silicon oxide polymers, generally known as the silicones, are today satisfying many electrical insulation requirements up to 250° C.

The silicone fluids used as liquid dielectrics are stable for remarkably long periods at 200°C. when used in sealed containers. The silicone resins and varnishes in built-up form and as impregnants offer a low loss factor at radio frequencies and high resistance to moisture coupled with permissible operating temperatures as high as 250°C.

Silastic, the Dow Corning silicone rubber, has good dielectric properties over an extreme temperature range of —110 F. to 500°F. and has the added advantage of high heat conductivity.

It is quite possible that your readers would be interested in hearing more about the high temperature silicone electrical insulating materials since more and more emphasis is being placed on high temperature operation of electronic equipment—with resulting savings in weight and space. We have a number of leaflets on these silicone materials.

G. E. McIntyre — *Dow Corning Corp., Midland, Mich.*

Qualification Tests At Government Laboratories

Editors, Tele-Tech:

Reference is made to your article, "How to Sell to Uncle Sam", which appeared in the October issue of Tele-Tech Magazine. An error is noted in the section of the article on the Armed Services Electro Standards Agency. The Agency does not award contracts to commercial laboratories for the testing of components, parts and materials. Qualification tests are performed at government laboratories on samples voluntarily submitted by manufacturers and the results forwarded to ASESA where approval certificates are issued if the tested items are satisfactory. Since the establishment of approved sources of supply is one of the primary objectives in the standardization program, all component part manufacturers who feel that they can meet the specification requirements are encouraged to submit samples for test.

W are very glad to be mentioned in your article as it is believed that a better understanding of the purpose and functions of ASESA on the part of industry will greatly assist the military standardization program.

Capt. Henry E. Bernstein, USN
Co-Director of ASESA
Fort Monmouth, N. J.

Most Graphic Picture of FM Progress

Editors, Tele-Tech:

Referring to your chart "Areas of Dependable Satisfactory Radio Reception — FM vs AM" which accompanied your August issue, I must say that to my mind this represents the most graphic picture of such a comparison of any single piece of literature on the subject that I have seen to date. No doubt it will do much in pushing FM to the fore this fall and winter.

Some remarkable things show up in this map:

(a) Take away a few AM 50-kw stations and the FM coverage picture far exceeds the AM coverage areas supplied by the regional and local stations.

(b) FM coverage in Louisiana, Alabama, Georgia, Florida, Arkansas, Missouri, Wisconsin, South Carolina, North Carolina, Virginia, Kentucky, Pennsylvania, New York, West Virginia, Maine and other states is already doing a better coverage job in its fourth postwar year than AM has been able to do in its development over the past 27 years.

(c) Total FM coverage in square miles even at this early stage is about equal to what AM coverage is (though naturally not in the same areas.)

With sincere personal thanks to you for what you have done to promote FM,

Everett L. Dillard, General Manager
Commercial Radio Equipment Co.
International Building
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For HEAVY DUTY WORK!
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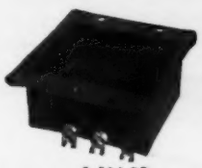

S-506-DB
Socket with deep Bracket

For 5,000 Volts, 25 Amperes per Contact Alterable by circuit Characteristics.

Socket contacts of phosphor bronze, knife-switch type, cadmium plated. Plug contacts hard brass, cadmium plated. Made in 2, 4, 6, 8, 10, and 12 contacts. Plugs and sockets polarized. Long leakage path from terminal, and terminal to ground. Caps and brackets, steel parkerized (*rust-proofed*). Plug and socket blocks interchangeable in caps and brackets. Terminal connections most accessible. Cap insulated with canvas bakelite.

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LEDEX

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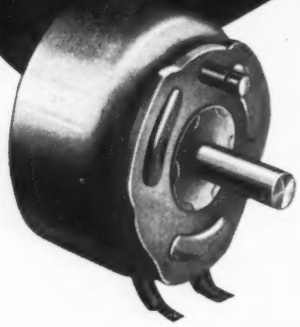

SOLVES MANY REMOTE CONTROL PROBLEMS

The many production applications of Ledex Rotary Solenoids vary from the dependable, snap-action tripping of airborne bomb releases to the actuation of rugged, hydraulic valves in heavy duty materials handling equipment.

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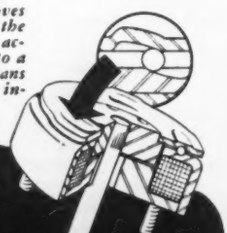
We supply to quantity users and solicit the opportunity to be of assistance in engineering a Ledex Rotary Solenoid to meet your product's requirements.

MODEL NO.	2	5	6	7	8
Diameter	1⅛"	1⅞"	2¼"	2¾"	3⅜"
Torque lb./inches	¼	5	10	25	50
Weight lbs.	⅛	½	1	2¼	4¼

Magnetic action moves the armature along the solenoid axis. This action is converted into a rotary motion by means of ball bearings on inclined races.



WRITE DIRECT TO

G. H. Leland INC.

137 WEBSTER STREET

DAYTON 2, OHIO

MULTIPLEXING FILM CAMERAS

(*Continued from page* 35)

ground stainless steel to prevent rust and corrosion and to keep carriages in perfect alignment. Also supported by slide rods are four "Alnico" #5 permanent magnet stops which accurately hold the carriages in the location desired.

The micro switches for the signaling system are attached to these same units. All electrical connections for the signaling devices are cabled down through the pedestal to a junction box which is readily accessible at the base. Each cast aluminum carriage on slide rods has two mirrors which are front face silvered mirrors with ground edges and rounded corners. The mirror holding brackets are adjustable in all planes with a seven degree swing each way from a horizontal plane and a seven degree swing each way from a vertical plane or a one and one half inch per foot of length of focus swing in each direction. Once properly located, they can be locked in place. Adjustment of mirrors can be made in all planes with only three "Allen" socket-head cap screws and locked with check nut. Only one "Allen" type and one open end wrench is required to make all adjustments necessary.

For both the multiplexer and the camera turret, the pedestal is made of steel tubing with cold rolled steel rings welded solidly together, heavy gage being used to absorb building rumble and vibrations. Four holes in the base plates are provided for lagging to the floor. The basic design philosophy has been rigidity of components, allowing movable parts to function without play, while eliminating sources of vibration. Carriages on the multiplexer were mounted as closely as mechanically possible to keep focus errors to a minimum. Except for the top surface and top surface components of the multiplexer which are optically black, all vertical surfaces are painted "Gray" crackle and horizontal surfaces "Gray" enamel.

The floor plan of the ABC television center in Hollywood using the above units is shown in Fig. 5. A total of twelve projector positions are available for the three film cameras shown. Under most conditions both the 16 mm and 35 mm projectors have two film cameras available for protection against camera failure. This equipment layout has been satisfactorily used at KECA-TV since its premiere opening on Sept. 16, 1949. The arrangement provides a degree of convenience and flexibility of operation that is highly desirable in network originating and key stations.

KPIX to Demonstrate Color to FCC

Television KPIX, San Francisco, has been granted a 60-day extension of its special authority covering color television transmissions. KPIX is cooperating with Color Television, Inc. of San Francisco in tests incident to the presentation of the latter's plan to the FCC during the current color hearings. CTI will demonstrate its color in San Francisco from November 28 to 30.

WHAS-TV Buys 12-Bay Antenna

A 12-bay super-gain television antenna, one of the largest ever built, will be delivered to station WHAS-TV, Louisville, Ky., by the General Electric Company's Transmitter Division, Syracuse, N. Y.

The antenna weighs four tons and is 86-ft. long and will take electric power equivalent to that used in a dozen average homes to keep ice forming on it in the winter.

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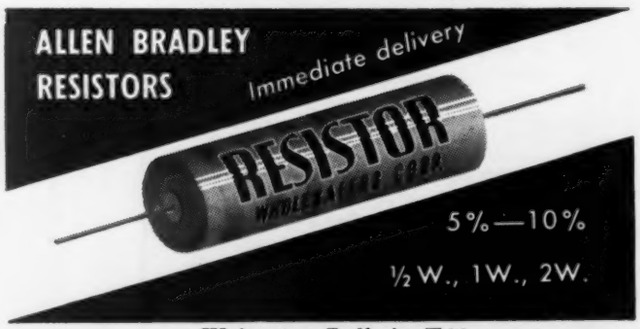

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From fundamentals the book proceeds logically through detailed discussions, covers every important circuit and essential application.

We could reprint many words of praise from owners of this book, but we prefer that you come to your own considered opinion of its value. Therefore we want to send you a copy for your five day free inspection.

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- *Vacuum Tubes as Circuit Elements*

Electronic Circuit Fundamentals
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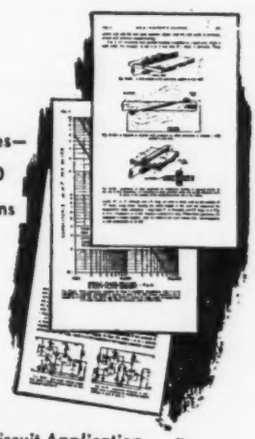

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SPDT Contacts. 2 coils at 700 ohms & 3300 ohms. Operating current with coils in series 6.6 ma. Release current 5.2 ma. Operated under specified conditions, relay has a life expectancy of 1000 hours at 60 operations per second.

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Linear Sawtooth Potentiometer

W.E. No. KS 15138

The d-c potentiometer consists of a closed type die-cast aluminum alloy frame consisting of a continuous resistance winding to which electric power is supplied through two fixed taps 180 degrees apart. Two rotating brushes (180 degrees apart and bearing on the resistance winding) and two take-off brushes are provided for the output voltage. Varying the position of the brushes varies the output voltage in accordance with a linear sawtooth wave. The potentiometer is excited with 24-volt direct current, is arranged for panel or bracket mounting, is approximately 3-11/16 inches in diameter, 3 inches deep, 4¾ inches long, and has an approximate weight of one pound. External connections are made through a standard AN type connector.

Brand New $5.75

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2J61	3000-3100 mc.	35 KW.	$65.00
2J62	2914-3010 mc.	35 KW.	$65.00
3J31	24,000 mc.	50 KW.	$55.00
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714AY			$25.00
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728	AY, BY, CY, DY, EY, FY, GY		$50.00
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Klystrons.	723A/B $12.50; 707B W/Cavity		$20.00
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Gauss	Pole Diam.	Spacing	Price
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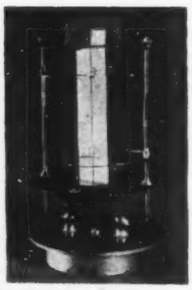

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JK CRYSTALS

BULLETINS

Potentiometers

A new bulletin has been released which describes in considerable detail the TIC line of 2-in high precision linear and non-linear potentiometers. Information is also included on the design of non-linear potentiometers which will be of assistance to equipment designers who are faced with the problem of finding an economical solution to their non-linear potentiometer requirements. Write to Technology Instrument Corp., 1058 Main St., Waltham 54, Mass. (Mention T-T)

Relays

Catalog D-20A has just been issued by Ward Leonard Electric Co., Mount Vernon, N. Y., illustrating and describing various types of relays, and giving contact ratings, coil specifications sizes, current list prices, and other helpful data on AC and DC units. (Mention T-T)

Plugs and Switches

Jacks, plugs, and switches are featured in bulletin S49, just released by Switchcraft, Inc., 1328-30 North Halsted St., Chicago 22, Ill. Drawings as well as photo and detailed descriptions are included. (Mention T-T)

Electronic Flash Lamps

Amglo electronic flash lamps are the subjects of a new bulletin issued by the Amglo Corp., 4234 Lincoln Ave., Chicago 18, Ill. Price information for industrial accounts and educational institutions is included. (Mention T-T)

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946.

Of TELE-TECH, published monthly at Orange, Conn., for Oct. 1, 1949.

1. The names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, M. Clements, Rumson, N. J. Editor, Orestes H. Caldwell Catrock Road and Bible St., Cos Cob, Conn. Associate Editor, B. F. Osbahr, 206 Eighth Ave., Brooklyn 15, N. Y. Business Manager, M. H. Newton, 583 W. 215th St., New York, N. Y.

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership, or other unincorporated firm its name and address, as well as those of each individual member, must be given.) Caldwell-Clements, Inc., 480 Lexington Avenue, New York 17, N. Y., M. Clements, O. H. Caldwell, Charles A. Petersen, Trustees, 480 Lexington Ave., N. Y. C. M. Clements, Trustee, Rumson, N. J. O. H. Caldwell, Trustee, Catrock Rd. and Bible St., Cos Cob, Conn. Charles A. Petersen, Trustee, 474 Senator St., Brooklyn, N. Y.

3. The known bondholders, mortgager, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortages, or other securities are: (If there are not any, so state.) None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding date shown above was: (This information is required from daily, weekly, semiweekly, and triweekly newspapers only.)

(Signed) Orestes H. Caldwell

Sworn to and subscribed before me this 28th day of September, 1949.

Belle M. Phillips

Notary Public New York and Westchester County

(My commission expires March 30, 1950.)

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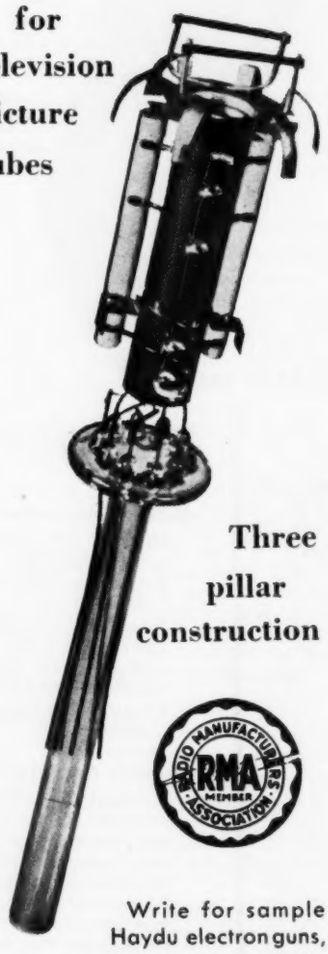
for television picture tubes



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TOGGLE AND PUSH SWITCHES

FIG. A FIG. B FIG. C FIG. D FIG. E FIG. F FIG. G FIG. H FIG. K FIG. I FIG. W FIG. N

STOCK NUMBER	FIG.	CONTACT	CONTACT ARRANGEMENT	MANUFACTURER & NUMBER	TYPE LEVER	MOUNTING DATA	UNIT PRICE
370-1	A	5a - 125v.	SPST MOMENTARY	CH AN-3022-NB	BAT ⅝	1-13.16 MTG C.	$0.25
370-4	A	5a - 125v	SPDT CENTER OFF	CH B-9A	BAT ⅝	1-13.16 MTG C.	.35
370-14	A	5a - 125v	SPDT CEN. OFF 1 SIDE MOM.	CH B-7A	BAT ⅝	1-13.16 MTG C.	.30
370-25	A	5a - 125v	SPST MOMENTARY	CH B-6B	BAT ⅝	1-13.16 MTG C.	.25
IT-108	A	5a - 125v	SPDT CENTER OFF	CH AN-3022-1B	BAT ⅝	1-13.16 MTG C.	.38
IT-102	A	5a - 125v	SPDT MOMENTARY	CH S21582	BAT ⅝	1-13.16 MTG C.	.30
IT-105	A	5a - 125v	SPST	CH B-5A	BAT ⅝	1-13.16 MTG C.	.35
IT-104	A	20a - 24v	SPDT 1 SIDE MOMENTARY	CH N905856B	BAT ⅝	1-13.16 MTG C.	.35
IT-109	B	5a - 125v	SPST MOMENTARY	CH B-19	BAT ⅝ ARM	1-13.16 MTG C.	.35
303-65	C	20a - 125v	DPDT	CH AN-3023-2	BAT	1-13.16 MTG C.	.45
309-163	C	20a - 125v	DPDT CEN. OFF MOMENTARY	CH C-11	BAT ⅝	1-13.16 MTG C.	.55
309-162	C	20a - 125v	DPST	CH C-1	BAT ⅝	1-13.16 MTG C.	.45
309-164	C	20a - 125v	DPST MOMENTARY	CH S7114K3	BAT	1-13.16 MTG C.	.40
370-11	C	20a - 125v	DPDT	CH C-1B	BAT ⅝	1-13.16 MTG C.	.55
305-87	D	5a - 125v	1 SIDE DPST MOM 1 SIDE SPST	AH&H	BAIL	8-32 BUSHING	.95
305-113	F	5a - 125v	SPST MOMENTARY	CH S8167Z	BAT	7 16-32 BUSHING	.28
305-153	F	5a - 125v	SPDT CENTER OFF	CH AN-3021-1B	BAT ⅝	7 16-32 BUSHING	.28
IT-106	F	3a - 250v	SPST	CH	BAT	7 16-32 BUSHING	.22
IT-101	F	5a - 125v	SPST MOMENTARY	AH&H w LEADS	BAIL	7 16-32 BUSHING	.20
301-51	G	5a - 125v	4PDT MOMENTARY	CH N905814	BAT	1-13.16 MTG C.	.75
IT-108	G	20a - 125V	3PDT	CH N7444K5	BAT	1¼ x ⅝ MTG C.	.69
305-140	H	3a - 125v	DT NO MAKE EACH SIDE	OPEN FRAME	BAIL	3 8-30 BUSHING	.25
309-161	K	50a - 125v	SPST	CH N7814K3	BAT ⅝	1-13.16 MTG C.	1.95
301-12	L	20a - 125v	DPST	AH&H	BAKELITE	2-3 8 MTG C.	1.25
305-76	I	30a - 250v	DPST	AH&H OPEN FRAME	BAKELITE	3-1.4 MTG C.	.75
301-12	M	5a - 125v	DPST	AH&H SPECIAL FOR HANDY TALKIE		7 16-32 BUSHING	.40
IT-107	N	3a - 250v	DPST	AH&H	SHORT BAT	7 16-32 BUSHING	.25

⅝ INDICATES A LUMINISCENT TIP

FIG. A FIG. B FIG. C FIG. D FIG. F FIG. F FIG. G FIG. H FIG. K FIG. I FIG. W FIG. N

STOCK NUMBER	FIG.	CONTACTS	MOUNTING DATA	BUSHING LENGTH	KNOB	ADDITIONAL INFORMATION	UNIT PRICE
301-39	A	N.O.	3 8-32 THD.	3 16	BLACK BAKELITE	USED ON SCR-300	$0.15
303-68	A	SPDT	3 8-32 THD.	3 8	BLACK BAKELITE		.25
303-75	A	3 MAKE	3 8-32 THD.	3 8	RED OR GREEN PLASTIC		.35
303-77	B	N.O.	3 8-32 THD.	3 8	BLACK BAKELITE		.25
305-163	B	DPDT	3 8-32 THD.	3 8	BLACK BAKELITE		.37
303-70	C	DPST N.C.	7 16-32 THD.	1 2	METAL		.25
370-13	C	N.O.	7 16-32 THD.	7 16	METAL w PLASTIC TIP		.25
IP-101	C	N.O.	7 16-32 THD.	1/2	METAL	GENERAL ELECTRIC	.25
IP-102	C	DPST N.C.	7 16-32 THD.	1 2	METAL	AH&H	.25
IP-103	C	N.O.	7 16-32 THD.	1 2	METAL	CUTLER HAMMER	.30
309-155	D	N.O.	END OF CORD		BLACK BAKELITE	MARKED SA-26 U	.60
370-35	I	N.O.	1-7 16 MTG C.		METAL CAP	SIGNAL CORPS SW-180	.25
309-166	K	2 MAKE	5 8 MTG C.		BLACK BAKELITE	SW-109 PUR T-17 WIRE	.35
370-9	F	N.O.				CH #S81K509	.50
31.-77	G	2 N.O.	END OF CORD		BLACK BAKELITE	SIGNAL CORPS SW-141-G	.30
370-26	h	N.O.	1-1.8 MTG C.		BLACK BAKELITE		.25
309-99	h	N.O.	5 8" PRESS FIT		BLACK BAKELITE		.25
370-21	h	N.O.	3 4" PRESS FIT		WHITE PLASTIC	3 SCREW TERMINALS	.35
301-40	I	N.C.	7 16-32 THD.	7/16	BLACK BAKELITE		.30
303-69	I	N.C.	7 16-32 THD.	1/2	BLACK BAKELITE		.25
301-94	w	N.O.	5 8-28 THD.	3/4	BLACK BAKELITE		.18
370-37	w	N.O.	5 8-28 THD.	1/4	WHITE BAKELITE		.25
303-35	w	N.O.	5 8-28 THD.	1/4	BLACK BAKELITE		.15
370-39	x	SPST N.O.	5 8 PRESS FIT		CHROME		.30
305-139	-	3 N.O. & 3 N.C.	15 32-32 THD.	1/2	BLACK BAKELITE	ASSEMBLY OF 3 SWITCHETTES	.89
370-7	-	N.O.	1" CABLE CLAMP		GREEN ENAMELED	WITH 3 CONDUCTOR CABLE	.35
370-40	-	N.O.	1-13 16 MTG C.		METAL	SIMILAR TO MICRO SWITCH	.89

Micro Switches

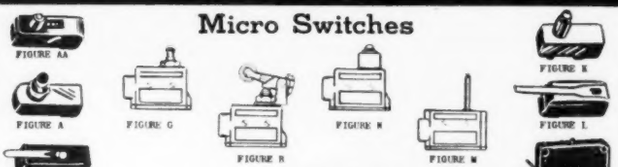


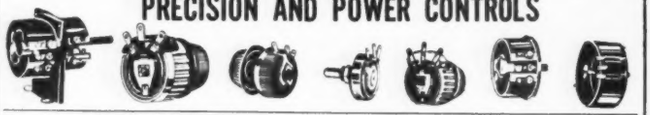
FIGURE AA FIGURE K FIGURE A FIGURE G FIGURE N FIGURE L FIGURE R FIGURE W FIGURE B FIGURE P FIGURE C FIGURE D FIGURE E FIGURE F FIGURE H FIGURE Q

STOCK NUMBER	MANUFACTURER	MFR. TYPE NO.	CONTACTS	ILLUSTRATION	TERMINALS	OUTER CASE	PRICE EACH
305-10	Microswitch	MP3N5	N.C.	FIG. AA	SCREW	Bakelite	$0.40
307-210	"	YP3A	N.O.	FIG. AA	"	"	.50
306-75	"	YZ-8A1	N.O.	FIG. A	SOLDER	"	.92
306-67	"	YZ7A8A	N.O.	FIG. A	SCREW	"	.71
I-1001	"	R-8T	SPDT	FIG. B	SOLDER	"	.71
301-46	MI-Switch	MIR-321	SPDT	FIG. B	"	"	.85
301-63	Microswitch	YZ-21TC 1	SPDT	FIG. B	"	"	1.01
301-30	MI-Switch	R32M	SPDT	FIG. B	"	"	.70
301-78	"	Green Dot	DPST	FIG. B	"	"	.75
306-74	Microswitch	BZ-RL32	SPDT	FIG. B	"	"	.75
305-154	Aero	X34-51	SPDT	FIG. B	"	"	.75
311-115	Microswitch	WZR31	N.C.	FIG. C	SCREW	"	.71
305-161	"	YZ7R3	N.C.	FIG. C	SOLDER	"	.71
311-123	"	WZ-7R	N.C.	FIG. C	"	"	.66
370-24	"	YZ-R31	N.O.	FIG. C	SCREW	"	.66
370-6	"	YZ7R	N.O.	FIG. C	SOLDER	"	.45
306-1	"	YZ7R1C	N.C.	FIG. C	"	"	.45
311-116	"	SM-1R6	N.C.	FIG. D	"	"	.55
303-43	"	YZ21ST	DPST	FIG. D	SCREW	"	.63
306-63	"	SBR305	DPST	FIG. D	"	"	.68
370-17	MI-Switch	QRS	DPST	FIG. D	SOLDER	"	.99
305-64	Microswitch	WZR12	N.C.	FIG. E	"	"	.75
305-62	"	R-8T2	N.C.	FIG. E	"	"	.95
311-25	MI-Switch	CIN24155	N.C.	FIG. E	"	"	.65
370-10	Aero	R32M12T	N.O.	FIG. E	SCREW	"	.85
306-72	Microswitch	YZ-3RW2T	N.O.	FIG. F	"	"	.70
306-10	"	BZE-2RQ4TM1	SPDT	FIG. F	"	"	.85
306-101	"	BZ-2RW221	SPDT	FIG. G	"	Metal	2.40
I 306-101D	Aero	R-7-X5869	SPDT	FIG. H	SOLDER	Bakelite	.95
370-18	"	HM17P2TSF1	N.O.	FIG. K	SCREW	"	.55
370-14	Microswitch	YZR441	N.O.	FIG. K	"	"	.70
370-49	Cutler Hammer		N.O.	FIG. K	"	"	.65
303-31	Microswitch	BZ-2RWTC	SPDT	FIG. K	"	"	.75
370-9	"	RA-11-R63	SPDT	FIG. W	SOLDER	"	.92
306-127	MI-Switch		N.C.	FIG. N	SCREW	Metal	1.50
370-15	"	A8R203	N.C.	FIG. N	"	"	1.15
370-2	Microswitch	BZE-2RQ7A	N.C.	FIG. N	"	"	1.25
305-11	Aero	2R-31A	N.O.	FIG. N	"	"	1.15
305-71	"	2R-30A	N.O.	FIG. P	SOLDER	Bakelite	.37
305-50	Microswitch	Open Type	SPDT	FIG. P	"	"	.37
370-28	"	YZ-R922	N.O.	FIG. Q	"	"	.37
				FIG. R	SCREW	Metal	2.75

SWITCHETTE

STOCK NO.	MANUFACTURER'S TYPE NUMBER	CONTACTS	TERMINAL LOCATION	UNIT PRICE
303-20	CR1070C103-A3	N.C.	SIDE	$0.47
301-29	CR1070C103-B3	N.O.	END	.47
303-34	CR1070C103-C3	1-N.O. 1-N.C.	END	.47
303-21	CR1070C103-F3	1-N.O. 1-N.C.	SIDE	.47
303-14	CR1070C103-E3	N.O.	SIDE	.47
303-43	CR1070C123-B3	N.O.	END	.47
303-23	CR1070C123-C3	1-N.O. 1-N.C.	END	.47
305-83	CR1070C123-J2	SPDT	END	.47
303-22	CR1070C123-14	SPDT	END	.47
303-17	CR1070C124-N4	SPDT	SIDE	.47
303-16	CR1070C128-C3	1-N.O. 1-N.C.	END	.47

PRECISION AND POWER CONTROLS



STOCK NO.	RES. OHMS	WATTS	BODY DIA.	SHAFT LGTH	MFR	GENERAL DESCRIPTION	PRICE
321-151	200	6	3"	4"	Dr Jur.	Meter type,precision.	11.25
400-1	10M-dual	6	3"	1¼"	Dr Jur.	Meter type,with mtg. bkt.	3.00
301-90	20M	6	3"	¼"	Dr Jur.	Meter type.	1.25
321-142	5	25	1-9/16"	SD Slot.	Ohmite.	Type H,Inch type bushing.	0.94
RH-25	6	25	1-9/16"	SD Slot.	Ohmite.	Type H.	0.94
321-150	8	25	1-9/16"	¼"	Ohmite.	Type H.	0.94
321-149	10	25	1-9/16"	¼"	Ohmite.	Type H.	0.94
321-124	50	25	1-9/16"	SD Slot.	Ohmite.	Type H, Inch type bushing.	0.94
RH-26	60	25	1-9/16"	SD. Slot.	Ohmite.	Type H, Inch type bushing	0.94
345-6	75	25	1-9/16"	7/16"	Ohmite.	Type H.	0.94
321-163	100	25	1"	¼"	Ohmite.	Aircraft, AN 3155-25-100	0.96
321-133	100	25	1-9/16"	SD. Slot.	Har. Hin.	Type R25	0.96
353-112	125	25	1-9/16"	7/16"	Ohmite.	Type H.	0.96
353-111	125	25	1-9/16"	7/16"	Ohmite.	Type H.	0.96
321-160	100	25	1-9/16"	SD. Slot.	Ohmite.	Type H.	0.96
313-74	140	25	1-7 8"	7/16"	Ohmite	Cockpit lamp type.	0.96
400-2	145	25	1-3/4"	7/16"	Grimes.	Cockpit lamp type.	0.96
321-137	150	25	1-5/8"	7/16"	Clarostat		0.96
315-42	175	25	1-9/16"	SD. Slot.	Ohmite.	Type H.	0.96
305-146	175	25	1-9/16"	SD. Slot.	Har. Hin.	Type R25	0.96
321-164	175	25	1-9/16"	7/16"	Ward L.		0.96
RH-27	200	25	1-5/8"	7/16"	Ward L.		0.96
313-72	200	25	1-3/4"	7/16"	Ohmite.	Type D.	0.96
321-141	350	25	1-9/16"	5/16"	Har-Hin.	Type R25.	0.96
321-165	750	25	1-9/16"	7/16"	Ohmite.	Type H.	0.98
321-143	5M	25	1-9/16"	SD. Slot.	Ohmite.	Type H.	1.10
RH-28	10M	25	5-3/8"	1/2"	Ohmite.	Type 433AC, Linear.	1.14
321 162	5	50	2-1/2"	7/16"	Ohmite.	Aircraft - AN-3155-50-5	1.08
315-43	30	50	2-1/2"	7/16"	Ohmite.	Type 03A.Aircraft Enclosed.	1.08
309-123	50	50	2-3/8"	7/16"	Ohmite.	Aircraft Power Type.	1.08
321.134	125	50	2-1/2"	S.D Slot.	Har-Hin.	Type B50 - 630 Amps.	1.10
313-73	150	50	2-1/2"	7/16"	Ohmite.	Aircraft,Type AN-3155.50.150	1.10
353-110	150	50	2-1/2"	S.D Slot.	Har-Hin.	Type B50 577 Amps.	1.10
321-90	200	50	2-1/2"	7/16"	Ohmite.	Aircraft Type AN-3155-50-200	1.10
313-71	200	50	2-1/2"	SD Slot.	Har-Hin.	Type B50	1.10
309.121	500	50	2-1/2"	SD Slot.	Har-Hin.	Type B50	1.12
321-133	500	50	2-1/2"	SD Slot.	Har-Hin.	Type B50	1.12
309.123	5	100	3"	1/2"	Har-Hin.	Type C100	1.68
309.120	5	100	3"	7/16"	Ohmite.	Type R-4-47 Amp.	1.68
353.113	100	100	3"	1/2"	Har-Hin.	Type C100, 1 Amp.	1.75
400-3	10	100	3"	1/2"	Har-Hin.	Type C100, 3.18 Amp.	1.68
321-153	1.5	150	4"	1/2"	Har-Hin.	Type D150, 10 Amp.	2.35
311-104	5	150	4"	7/16"	Ohmite.	Type L, 5.48 Amps.	2.25
321.155	750	150	4"	1/2"	Har-Hin.	Type D150,.447 Amp.	2.75
309.122	2250	150	4"	7/16"	Ohmite.	Type L, .25 Amp.	2.95

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2.	20.	Lugs	Utah	19¢
2.75	150.	Lugs	Utah	55¢
3.	10.	Leads	-	13¢
5.	100.	Lugs		50¢
10.	25.	Lugs	Mallory	22¢
10.	20.	Lugs		19¢
15.	20.	Lugs	Mallory	19¢
15.	35.	Lugs	Ward-L.	21¢
20.	200.	Lugs	Ohmite	82¢
25.	50.	Lugs	Ohmite	33¢
50.	10.	Lugs	Ohmite	15¢
50.	20.	Lugs	Clarostat	19¢

OHMS RES	WATTS	TYPE	MFR	PRICE EACH
20.	10.	Lugs	Ward-L.	19¢
20.	10.	Leads	Ohmite	17¢
110.	45.	Lugs	Mallory	24¢
200.	10.	Lugs	Ohmite	17¢
225.	50.	Lugs	Mallory	35¢
360.	20.	Lugs	IRC	20¢
750.	25.	Lugs	Utah	23¢
2500.	100.	Lugs	Lectrohm	63¢
2500.	25.	Lugs		24¢
5M.	200.	Lugs	Clarostat	92¢
7500.	50.	Lugs	-	50¢
25M.	50.	Lugs	-	50¢
400.	20.	Lugs	Ohmite	20¢

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1N21H Xtal Diode	.80	6SJ7-GT	.85	FG-172	29.50
1N23 Xtal Diode	.80	6SK7-GT	.65	205B	1.95
1N23A Xtal Diode	.85	6SL7-GT	.80	211 (VT-4-C)	.68
1N27 Xtal Diode	.85	6SN7-GT	.80	215A	1.95
1R4-1294	.65	6SQ7-GT	.60	231D	1.30
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2C26A	.45	7F7	.75	350B	2.50
2C34	.75	7H7	.75	371B	.85
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2J22	9.85	7Q7	.65	417A	19.95
2J26	8.45	10 VT-25A	.40	434A	7.40
2J27	14.45	10Y VT-25	.45	446A	1.50
2J31	9.95	12A6	.25	450TH	19.95
2J32	14.85	12K7	.65	GL-471A	2.75
2J33	19.95	12SF7	.70	527	11.25
2J37	13.85	12SH7	.60	WL-530	17.50
2J38	12.95	12SK7	.60	WL-531	17.50
2J48	14.95	12SL7 GT	.70	532A/1B32	3.50
2X2/879	.65	12SR7	.60	GL-559	3.75
3A4	.35	12x825 2 amp.		KU-610	7.40
3A5	1.05	Tungar	2.25	HY-812	1.20
3AP1 CRT	3.85	13A4 Ballast	.35	200B	9.95
3B22	2.95	15R	1.40	700A	9.95
3B24	1.75	FG-17	2.85	700D	9.95
3BP1 CRT	3.75	REL-21	2.25	702A	2.95
3CP1-S1	1.95	21M4 Ballast	.45	703A	4.85
3CP1-SRG	.47	25Z6-GT	.66	704A	2.65
3DG 1599	.65	28D7	.40	707A	19.50
3FP7 CRT	2.95	30 VT-67 (For		707B	23.25
3HP7 CRT	2.95	Walkie Talkies)	.75	710A	2.15
3GP1 CRT	3.75	33 VT-33(For		713A	1.58
3QP	.90	Walkie Talkies)	.75		
REL 5	17.95	RK-34	.45		
5AP1 CRT	3.95	34	.35		
5BP1 CRT	2.95	39-44	.35		
5CP1 CRT	3.88	45 Spec	.55		
5GP1 CRT	6.55	46	.50		
5T23	14.25	EF50 VT2-D	.45		
5T29	14.25	50 Q T	1.10		
5Y3G	.40	72-3B24	1.75		
6A6	.90	VR-75	.90		
6AB7	.95	76	.55		
6AC7	.90	VR-78	.65		
6AK6	.80	80	.45		
6B7	.95	FG-81-A	3.95		
6BE6	.65	83	.85		
6C4	.45	83V	.95		
6C6	.75	89Y	.40		
6C21	19.75	VR-90	.70		
6D6	.60	VR-92	.65		
6E5	.70	100B	3.25		
6H6	.50	FG-105	9.95		
6J5 GT	.50	VR-105	.85		
6J6	.50	VT-111	.66		
6N7 GT	.80	117Z3	.65		
6RG	.80	VT-127 English	.25		

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NE-2	$0.06
NE-15	.06
NE-16	.24
NE-20	.06
NE-21	.24
NE-48	.24
NE-51	.06

PILOT AND FLASHLIGHT BULBS

Stock No.	Mazda No.	Volts	Watts	Bulb	Base	Price
330-60	44	6.8	2CP	G-6	DC Bay	$0.07
330-61	47	6-8	1 CP	G-4½	Min. Bay	.08
330-62	1pcs	12	5	G-6	Cand. Sor.	.12
330-63	1445	12	2 amp.	G-6	Min. Bay	.07
330-18	49	2	.38	T-3¼	Min. Bay	.08
330-64	3/4	3	1	G-6	Cand. Sor.	.11
330-22	PR-10	6	3 amp.	B-8½	Min. Thing	.60
330-65	Proj. Bulb	1.35	10/35	T-20	Mod. Pf	1.45
LB-67 C		28	933 A	T-2	Tel. Base	.18
LB-68 A		110	25	C-7	Cand. Sor.	.07
LB-67 A	52	12-18V	1 CP		Min. Bay	.07
LB-68A Aerojet Headlight		24V	250W	A-18	Mod. Pf	.84
LB-101	222	3	1Amp(R)	T-3¼		.27
LB-101A	LM-66	115V	25W	T-20	Mod. Pf	.60
LB-102	1108	12-16	30 CP	BP-15	DC Bay	.14
LB-102A	1073	115V	100W	T-8	DC Pf	.24
LB-102B	1093	2.4	9 amp		DC Bay	.14
LB-103	1151	28	(Aerojet use)		Mod. Pf	.60
LB-108	318	28	15 amp	T-8½	Min. Bay	.14
LB-108	1088	115	25 W		Min. Bay	.12
LB-108	328	12	36-1	T-2	Tel. Base	.12
LB-109	36-44 NE	28	75 MS	T-20	Tel. Base	.18
LB-109	0-44 Argon	105	25 Watt		Mod. Pf	.60
LB-109	1447	Telephone Type	5 amp	T-2		.12
LB-110		28	75	T-3	Min Ser.	.36

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